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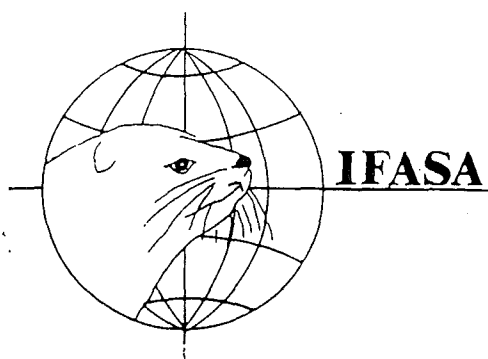
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Welcome to the new Fur Animal and SCIENTIFUR year where we can all feel optimistic due to the recent auction prices especially of foxes, but also of mink.

We in IFASA and SCIENTIFUR can look back on a year when the trend regarding number of members as well as subscribers increased slightly. Together with the economic increase in the fur business this gives us the best hopes for the nearest future.

Also in the area of contributions to SCIENTIFUR in the form of original reports and reports to be abstracted there has been a remarkable increase. On this basis, and because we find it essential to get all this information to our readers as soon as possible, we have decided to accept the extra costs and work involved in publishing SCIENTIFUR No. 1 as a double number. We hope this initiative will be appreciated and that you will get the necessary time to consume all the important information in this issue.

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*Original Report*

## **Structural and functional features of the pineal gland of silver foxes: Changes under the effect of domestication**

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### **Summary**

The results of morphofunctional analysis of the pineal gland in relatively wild and domesticated silver foxes are presented. It was shown that not only the morphological and functional state of the pineal altered in domesticated males and females, but also the course of changes in the functional activity, when related to age, season and phase of reproductive cycle.

### **Introduction**

The pineal gland, a tiny organ located near the center of the brain, was thought to be a vestigial appendage until about 30 years ago. Numerous investigations have revealed that the pineal is one of the most universally acting organs in the body, being involved in the control of endocrine and reproductive physiology; more than that, its main hormone has been shown to be a potent free-radical scavenger (*Reiter, 1993*). Until recently, the morphology and physiology of the pineal was studied mainly in laboratory animals, while the literature concerning its activity in wild or domestic animals was scant. Our group became interested in the morphology and functional state of the pineal of silver

foxes and focused studies on the possible transformation of some characteristics related to the reproductive capacities of animals in man-made environments.

Many mammals have lost seasonality of reproduction and some monoestricty under the effect of domestication. It is known that this inherent pattern of sexual activity has been stabilized by natural selection and, hence, hereditary diversity is minimal. D.K. Belyaev has theoretically demonstrated the important role of behaviour in hereditary reorganisation of the morphological and functional systems in wild animals in the course of domestication (*Belyaev, 1962*). The experiment with selection of silver foxes for domestic behaviour carried out at the Institute of Cytology and Genetics provided support for his ideas.

Foxes are strictly monoestral in natural conditions. Their mating season starts by the end of January and lasts almost to the end of March, i.e., it is coincident with the period when the duration of day light increases. As expected, strict selection of foxes for absence of aggressive-defence responses to humans (domestication) produced correlated changes in the function of their reproductive system. In

domesticated foxes, onset of the mating season shifted to earlier than the usual dates (*Belyaev, Trut, 1983*). In some individuals, the reproductive system was activated outside the regular period, i.e., in December, in late spring, or, what is noteworthy, in autumn, when day light shortens, some foxes demonstrated the features of second sexual activation during the same reproductive season (*Belyaev, Trut, 1983*). These deviations may mean "abolition, or weakening, or, finally, change in the type of photoperiodic control of this vitally important function" (*Belyaev, 1972, p. 43*).

It is accepted that the duration of day length is crucial in reproduction onset and that the pineal gland has an important role in mediating light signals, because it is involved in synchronization of rhythmic activities of organ systems under environmental lighting (*Reiter, 1984, 1993; Armstrong et al., 1986; Wayne et al., 1988*). The pineal acts as a neuroendocrine transducer, a specific organ converting information of neural nature concerning light into hormonal, thereby making visual information available to all tissues and organs. This allows the organism to synchronize physiological rhythms with geophysical, such as diurnal and seasonal.

The secretory product of the pineal contains components of indole nature, such as serotonin, melatonin and their metabolites (*De Martino et al., 1963; Arstila, 1966; Reiter, 1991*). The two step conversion of serotonin into melatonin, the main pineal hormone, is light-sensitive; the involved enzyme N-acetyltransferase is 10-100 fold more active in the dark than in the light. Variations in melatonin concentration, which are directly related to the light regime, can be biochemical components of the biological clock, passing important time-of-day and seasonal information to all cells and serving both as a clock and a calendar (*Klein, Weller, 1970; Reiter, 1993, 1994*).

The mammalian pineal gland has evolved from the pineal of lower vertebrates. Its major part is the parietal (the so-called "third") eye. It has all the attributes of a light-sensitive organ, the cornea, the lens, the retina. Thus, the parenchymous cells of the mammalian pineal gland, secreting biologically active substances into blood, have derived from the

photoreceptor cells of the "third" eye of the lower vertebrates. This substitution is a unique example of evolutionary plasticity. The microevolutionary plasticity of the pineal has also been noted. Even closely related species sharply differ in size and histological organization of the pineal, which are under the control of ecological conditions (*Guello, Tramesani, 1969*). It has been suggested that the amount of pineal tissue and specificity of its histology are traits of adaptive significance and that the pineal may undergo both functional and morphological changes, when ecological conditions alter (*Kolesnikova, 1987*).

### Materials and methods

The aim of this study is to compare the morphological indices of the physiological activity of the pineal in unselected (relatively wild) and domesticated silver foxes. The pineal is examined here as an organ mediating the effect of photoperiodicity on reproduction with the use of stereological analysis of semi-thin sections.

In analysis of the morphofunctional state of the pineal taken into account were: the absolute and relative weights, the ratio of parenchymous and stromal elements, the numbers of light (more active), dark and intermediate types of pinealocytes, their sizes, diameter, volume, surface area of cells, and nuclei, and, in a number of cases, the concentration of serotonin and melatonin in the pineal. The pineals were isolated from foxes killed by electric shock, and fixed in 0.1 M solution of paraformaldehyde in a phosphate buffer (pH 8.0). The procedures used to make the preparations were the same as in routine electron microscopy. 0.8  $\mu$ m semi-thin sections were stained with toluidine blue. The concentrations of serotonin and melatonin in pineal tissue were determined according to Miller and Maikel (1970). The estimates obtained in November-beginning of December for a large number of previously mated females of the commercial population were used as reference standard for studying changes due to selection for tame behaviour, as well as sex, age, season and stage of the sexual cycle. All foxes were maintained under the same conditions at the Experimental Fur Farm near Novosibirsk.

Three groups were under observation: (1) relatively wild, the commercial population, (2) foxes, subjected to selection for absence of aggressive-defense responses to humans (domesticated) with strictly rhythmic reproduction, and (3) domesticated, showing certain forms of extraseasonal sexual activity. In one experiment (Table 7), foxes, which were selected for aggressive responses to humans (aggressive), were used.

## Results and discussion

### *Histological characterization of the fox pineal*

The first morphological data for the silver fox pineal were obtained in relatively wild adult females during commercial sacrifice at the end of November-beginning of December. The daylength is about 8 hours in the latitudes of Novosibirsk at this time of the year. Morphological analysis and hormonal assays evidence that some foxes already then show signs of preparation for mating (Kolesnikova *et al.*, 1985).

The pineal gland of foxes is a small organ: at an average body weight of about 5 kg, its weight is 2.8 mg. In closely related species, the gland is larger, about 4 mg at the same body weight in the farm-bred polar fox and it is almost an order of magnitude heavier in the dog (Khelimsky, 1969a). To compare, the pineal is about 1 mg in the adult rat with a body weight of 200-300 g. The weight of the pineal in foxes shows wide individual variations from 1.1 to 6.5 mg. The variations were not associated with significant structural differences; no considerable age-related differences in pineal weight were observed.

In foxes, the pineal is kidney-shaped. In the majority of cases, a superficial transversal groove crosses the more convex dorsal aspect. The pineal is occasionally divided into two identical lobes attached to the pineal stalk. Like in other mammals, the pineal gland of foxes is covered by the connected tissue smooth-surfaced membrane, and its dorsal surface is covered by the meningeal membrane. Chromatophores render the pineal membrane grey (Khelimsky, 1969a). In this study, approximately 30% of the pineals appeared greyish during autumn-winter observations. The stroma of the fox pineal consists of vessels, branching in their course, and associated with connective tissue cells and fibrillar structures.

Unmyelinated and occasionally myelinated neural fibres innervating pineal parenchyma pass into the gland as a part of nn.conarii (Kappers, 1960). Parenchyma is structurally homogeneous, no distinct cell groups or connective tissue septa were revealed. Division into peripheral and central zones in autumn is hard to distinguish; the brain sand, a complex of calcium salts with byproducts of pineal hormonogenesis (Khelimsky, 1969b), detected in aged humans, was not revealed in the pineals even of 8-9 year old foxes.

The shape of the parenchymous cells is irregular; the nuclei are relatively large and oval. Based on staining intensity, the nuclei of pinealocytes may be divided into light, dark, and intermediate. These differences are made apparent by all the staining techniques. The light nuclei are larger. Their boundary with cytoplasm is clear-cut. Chromatin clumps are on the nuclear periphery, closely adhering to its membrane. The nucleolus then has the appearance of a large, dense, occasionally the sole, accumulation of chromatin. The dark nuclei contain finely dispersed and more uniformly distributed chromatin in karyoplasm. The nucleolus, as a rule, is hardly discernible. Cell cytoplasm around the light nucleus is more abundant and it occasionally appears lighter, however, no particular differences in its density and stainability were detected. Obviously, the light and dark nuclei in the pineal of the fox are counterparts of those described in other mammals (Quay, 1962; Arstila, 1966).

According to electron microscopic data distinctive features of the light cells include a smaller number of mitochondria and free ribosomes in the cytoplasm, lower electron density of the nucleus and a larger amount of a granular reticulum surrounding it (Arstila, 1966; Chasov, Isachenkov, 1974). This subdivision is somewhat tentative because differences between cell types and their nuclei are mainly quantitative. Moreover, there is a wide variety of intermediate staining intensities with predominance of features of light or dark cells and nuclei. It appears more correct to regard cells differing in staining as representatives of different functional states which are morphologically and physiologically identical (Arstila, 1966; Satodate *et al.*, 1970). Mitoses in pinealocytes of adult foxes are extremely rare, as previously reported for another animal (Quay, Levine, 1957; Khelimsky, 1969b).

There are granular inclusions in the cytoplasm of part of the pinealocytes. In foxes, the majority of such cells lie in the periphery of the gland near the connective tissue capsule. The number of cells with granular inclusions varies widely, without being appreciably related to age and pineal weight. The inclusions have the appearance of rounded homogeneous granules intensely staining by the Gomori-Gab technique like hypothalamic PAF-positive neurosecretion. The same has been observed for rodents (Milofsky, 1957). The same has been observed for rodents (Milofsky, 1957). The frequent perivascular location of granular accumulations suggests that the biologically active substances they contain can be released into the blood. Such granules have been described in the pineal of other mammals and man; they are thought to contain lipids, melatonin and serotonin (De Martino *et al.*, 1963; Osinchak, 1963; Arstila, 1966). Granules in the fox pineal stain for lipids with Sudan III. They change in colour from native dark brownish to light yellow, when treated with hydroxyperoxide, and this may be evidence for the presence of melanin.

It should be recalled that research on pineal secretion stopped in the sixties. It became limited to morphological descriptions of secretory material. Attention of pineologists shifted to the biochemistry of melatonin and term "secretion" was used, when comparing melatonin concentration in pineal tissue and plasma. In spite of some evidence that this process can be intense, and, hence, controlled, it was assumed that it is passive because of high melatonin lipophilicity. This attitude is not consistent with the numerous processes in which the pineal virtually participates.

*Morphofunctional state of the pineal in relatively wild and domesticated female foxes outside the mating season*

The most conspicuous and highly significant effect of domestication was an almost 25% decrease in pineal weight (Table 1). This raised the question: Was the reduced weight of the pineal gland due to a decrease in the number of the volume of pinealocytes, the major elements of pineal parenchyma?

Pinealocyte counts by the dissociation method (Belov *et al.*, 1975) demonstrated that their number per mg of pineal tissue of the relatively wild is smaller than that of the domesticated females. It is note-

worthy that their number in the whole pineal was virtually unaltered, being 375.000 in Gr. 1 and 368.000 in Gr. 2. Indirect analysis of the weight of parenchymous cells and stromal elements provides evidence for a proportional decrease in these characteristics in domesticated females.

Analysis of cell composition, sizes of the nuclei and cells of different types in pineal parenchyma at the very beginning of preparation to mating showed that its activity as an endocrine organ in domesticated foxes is decreased compared to relatively wild counterparts. Thus, there was an increase in the number of the less active dark cells, and, accordingly, in their total volume and the surface area of their nuclei. There was a parallel decrease in the ratio of the light to dark nuclei per area unit, in the volume of the more active light nuclei, in the relative volume and surface area of nuclei of all types and in the number of cells containing secretory granules (Table 2).

Such changes may evidence that basal metabolic rate (nonspecific protein synthesis) is suppressed the number of cells containing PAF-positive material, as well as scores for their amounts, demonstrate that the pineal parenchyma of domesticated foxes contains much less secretory material. According to the data in the literature, the pineal secretory product may contain melatonin, on the one hand, and melatonin has an inhibitory influence on the reproductive system, on the other hand. With this in mind, the decrease in pineal activity during preparation to mating may be one of the reasons why domesticated foxes become sexually active earlier than relatively wild foxes.

*Morphofunctional state of the pineal in relatively wild and domesticated foxes during the estral period*

Females of the two behavioural groups were taken in autumn; the groups were composed of foxes, which had been involved in matings, showing no abnormalities of the reproductive function and no deviations from strict seasonality. The pineal was removed on the day after mating. The period during which the unselected females came into estrous lasted from February 6th to March 2nd. In the domesticated foxes, this period lasted from January 30th to March 21st. Thus, when adjusted for other characteristics of sexual activity, the two groups were not identical with respect to heat onset.

**Table 1.** Morphological features of the pineal in relatively wild (1) and domesticated (2) foxes

Group	Weight of the pineal, mg	Number of pinealocytes/mg (thousands)	Weight of pinealocytes, mg	Weight of stromal elements, mg
1	2.81 ± 0.08 (111)	134 ± 35 (7)	1.95 ± 0.26 (5)	1.05 ± 0.10 (5)
2	2.12 ± 0.06* (116)	174 ± 46 (7)	1.22 ± 0.20* (5)	0.66 ± 0.08* (5)

\*: the differences are significant by Student's t-test.

**Table 2.** Characteristics of the morphofunctional state of the pineal in relatively wild (1) and domesticated (2) foxes at the period preparative to mating

Relative volume of nuclei of all type units/thousands	Total surface areas of nuclei of all types, mm <sup>2</sup>	Ratio of light to dark nuclei	Total surface areas of dark nuclei, mm <sup>2</sup>	Relative volume of dark cells, units/thousand
Group 1 821.2 ± 0.09 (5)	657.61 ± 64.21 (5)	2.0 ± 0.11 (20)	66.16 ± 4.97 (5)	202.40 ± 8.2 (5)
Group 2 558.5 ± 0.07* (5)	424.81 ± 68.95* (5)	1.7 ± 0.09 (17)	93.52 ± 4.49* (5)	256.00 ± 16.3* (5)

**Table 2 continued**

Volume of light nuclei, arbitrary units	Number of secretory granules, scores	Serotonin concentration, mkg/mg	Melatonin concentration, ng/mg
111.77 ± 3.20 (29)	0.96 ± 0.16 (20)	21.05 ± 2.40 (8)	2.54 ± 0.45 (7)
101.76 ± 3.44* (22)	0.61 ± 0.08* (20)	26.36 ± 1.83** (7)	4.23 ± 0.38* (7)

\*: the differences are significant by Student's t-test

\*\* : the differences are significant by Fisher's test

**Table 3.** Morphological features of the pineal in relatively wild (1) and domesticated (2) female foxes during estrous

Group	Pineal weight, mg	Relative number of light and dark nuclei	Linear density of nuclei	Mean volume of nuclei, arbitrary units	Number of secretory granules, scores
1	2.61 ± 0.13 9 (17)	1.8 ± 0.21 (12)	0.15 ± 0.012 (12)	118.93 ± 6.09 (12)	1.38 ± 0.23 (12)
2	1.90 ± 0.12* (17)	2.0 ± 0.23 (13)	0.16 ± 0.007 (13)	127.01 ± 5.39 (13)	0.98 ± 0.15 (13)

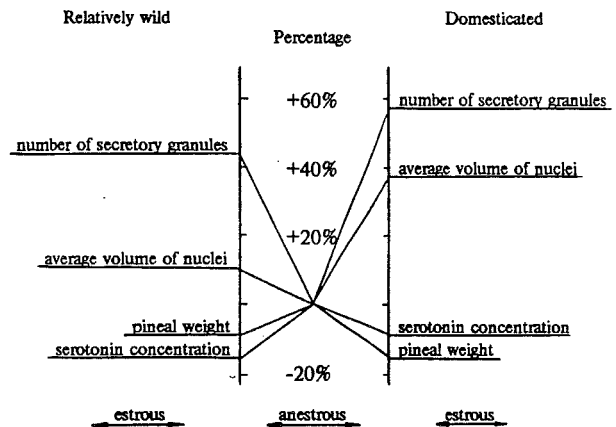
\*: differences are significant by Student's t-test.

The pineal weight of domesticated females remains significantly smaller; there are no differences compared to the estimates for autumn (Table 3). However, both groups showed similar signs of pineal activation.

The vessels of parenchyma, especially of its central zone, were dilated, filled with erythrocytes and the boundary between the zones became more distinct than outside the mating season. The peripheral zone, where the cellular elements are denser than in the center, contains abundant cells with light nuclei.

However, the two behavioural groups and the two periods of the year do not differ in the ratios of the light to dark nuclei, characterizing the activity of parenchyma, and also in the linear density of the nuclei, characterizing the relatively proportion of its cellular and connective tissue elements. Cells with granular inclusions were mostly located in the periphery, like during the period of preparation to mating.

The mean volume of all types of pinealocytes, as an integral index of pineal activity, was the same in foxes of both groups. However, its increment was markedly different compared to the period of anestrus: nuclear volume increased by 18.6% in the relatively wild and by 42.3% in the domesticated females (fig. 1). The increment in the amount of granular material was also larger in the tame foxes, but remained smaller than in Gr. 1.



**Fig. 1.** Changes in indices of the pineal activity in relatively wild and domesticated foxes during estrous as percentage of estimates obtained during anestrus.

The decrease in the amount of granular material at virtually the same volume of pinealocyte nuclei may evidence for enhanced secretion at the time of estrous, i.e., for higher hormone releasing activity of the pineal. It appears likely that the sharper changes in the activity of the pineal involved in the regulation of reproduction may partly have produced changes in heat onset in domesticated foxes. It is of interest that the indices of pineal activity in domesticated foxes differ not only at the time-points of comparisons, but also in the time course of changes.

This supports the view that complex and different mechanisms are engaged in the regulation of the sexual cycle and also suggest that there are several pathways for achieving the effect within each mechanism (the pineal in the given case).

*Morphofunctional state of the pineal in female foxes showing evidence of extraseasonal sexual activation*

The group of domesticated foxes showing once or repeatedly signs of extraseasonal heat during their reproductive life history was of particular interest (Gr. 3). Their extraseasonal sexual activity was confirmed by the condition of their genitals and composition of vaginal smears. Regardless of the time of extraseasonality, the pineal was taken in autumn, during preparation to mating for all foxes with normal rhythmicity. Their indices of pineal activity were compared to those of the relatively wild and domesticated foxes showing strict seasonality.

While foxes of the three groups did not differ in body weight, the absolute weight of the pineal of foxes showing signs of extraseasonality (Gr. 3) was considerably and significantly lower not only than in Gr. 1, but also than in Gr. 2, being  $1.83 \pm 0.08$  mg ( $n=70$ ). As a result, the difference in pineal weight between foxes of Grs. 1 and 3 reached almost 1 mg, 33% of that in the relatively wild foxes. Pinealocyte counts demonstrated that their number per mg of pineal tissue increased with decreasing weight, pinealocytes in the whole gland was 368,000, i.e., not different from that in Gr. 1 and 2 (Kolesnikova et al., 1988).

As noted, the pineal cells in silver foxes do not divide and mitoses are exceptional. Cell number in the pineal of adult foxes does not change during their lifetime, presumably being determined by its number in the embryonic pineal. The fact that pinealocyte number does not differ in all the studied groups justifies the belief that selection for behaviour does not produce correlated changes in the number of pinealocytes during embryogenesis. Reorganization of the seasonal pattern of reproduction does not correlate with these changes either.

Changes in weight, some decrease in sizes of pinealocytes and their nuclear volume in domesticated foxes showing strict seasonality suggest that their pineal activity is decreased outside the breeding

season compared to relatively wild foxes. In contrast, changes in pineal activity of females showing signs of extraseasonality were not as clear-cut. Some indices characterizing pineal structure evidence that deviation reached maximum: their mean pineal weight being minimal and the number of cells per mg of tissue being maximal. Concomitantly, functional characteristics, such as nuclear volume ( $92.97 \pm 2.68$ ;  $n=34$ ), number of secretory granules ( $0.96 \pm 0.15$ ;  $n=35$ ) did not differ from those in Gr. 1.

A possible explanation may be the heterogeneous composition of Gr. 3. Firstly, the group included females differing in intensities and regularities of extraseasonal activation, i.e., with differently changed seasonal patterns. Secondly, foxes of Gr. 3 were also heterogeneous with respect to the time of extraseasonality, i.e., the group was pooled, consisting both of females that already passed estrous or were approaching it at the time of study.

The following types of deviation from strict seasonality were observed: heat-like activity in October long before preparation to native mating (subgroup 1). Subgroup 2 included females with sexual activation in December, shortly before the natural season, which was frequently protracted up to 4 weeks, yet never passing to "real" estrous. Occasionally, activation in December terminated in heat (subgroup 3). Some foxes, sexually active in December, had recurrent heats and paired during the regular mating season (subgroup 4). There was another type of activation, late in April, as a rule, in those females, which did not mate, or when mated, did not give birth on the regular dates (subgroup 5). Extraseasonality was most frequently recorded in October. Exactly this type was extraseasonal, in the full sense of the term, because it occurred, quite paradoxically, when day length shortened, while its lengthening serves as a signal for mating onset of foxes in nature.

The pineal of foxes showing sexual activation in October (subgroup 1) differed in weight and mean nuclear volume of pinealocytes not only from tame females with strict seasonality, but also from groups showing other deviations (Table 4). It may be suggested that the pineal was the smallest in foxes precisely with the October deviation because their reproductive system was most reorganized to pro-

duce loss of seasonality under the effect of domestication.

*Morphofunctional state of the fox pineal during pregnancy*

Data that decreasing daylength shortens the duration of pregnancy, while increasing daylength increases the duration in rodents (*Ellendorf, Smidt, 1961; Mitchel, Yochin, 1970*), prompted us to study the functional state of the pineal in pregnant foxes.

Data on the functional state of the pineal during pregnancy are controversial. There is information that it is activated during the last phase of pregnancy and that its activity is decreased during its second half in association with its unaltered morphological and biochemical status. The general view is that the role of the pineal gland during pregnancy is unclear (*Karasek et al., 1982*).

In this study, all the relatively wild and domesticated foxes were selected in autumn outside the breeding season. They all were two-six years of age and they had been previously involved in matings. The

day after mating was taken as the first day of pregnancy. The foxes were sacrificed throughout the entire pregnancy. The material was collected for several years. Because pineal weight is considerably reduced in the group of domesticated foxes, it appeared worthwhile to analyze the possible time course of its changes. As shown in Table 5, there were no regular changes in pineal weight in both groups. The other characteristics of the functional state of the pineal, like its weight, did not change in foxes during pregnancy. The relative proportions of cells and nuclei of different types and their sizes remained virtually unaltered in both groups. Exceptional were the diameters of the light and dark pinealocyte nuclei. They were significantly larger both in domesticated and control foxes at the end of pregnancy (Table 6).

The similar state of the pineal and its similar course of changes during pregnancy in domesticated and relatively wild foxes is noteworthy. As noted, the pineal was less active in domesticated foxes during preparation to mating, but at heat onset its activity became almost the same in both groups because changes in Gr. 2 were more dramatic.

**Table 4.** Characteristics of the morphofunctional state of the pineal in domesticated female foxes with normal reproductive pattern and different rhythmicity deviations

Seasonal activation (normal)	Activation in October, subgroup 1	Activation in December, subgroup 2	Mating in December, subgroup 3	Recurring heat and mating, subgroup 4	Activation in April, subgroup 5	Average values for subgroups 2-5
Pineal weight, mg						
2.12±0.07 (116)	1.57±0.12*,** (15)	2.03±0.18 (10)	2.43±0.50 (3)	2.15±0.32 (4)	1.87±0.51 (6)	2.06±0.17 (23)
Average volume of nuclei, arbitrary units						
89.23±2.97 (27)	91.57±0.12 (6)	108.10±11.63 (4)	84.20±3.52 (3)	127.62±11.12 (2)	104.33±1.69 (6)	104.42±4.74 (15)
Number of secretory granules, scores						
0.61±0.08 (20)	1.30±0.38 (7)	0.28±0.12 (4)		0.28±0.24 (2)	0.84±0.30 (4)	0.50±0.15 (10)

\*: differences from normal are significant by Student's t-test

\*\* : differences from average for subgroups 2-5 are significant



**Table 5.** Pineal weight (mg) in foxes during pregnancy

Pregnancy (days)	Relatively wild	Domesticated
5-10	2.64 (5)	1.98 (5)
20-25	3.00 (3)	2.00 (2)
26-30	2.68 (4)	1.50 (4)
31-35	2.61 (5)	2.30 (5)
36-40	2.48 (4)	1.72 (6)
41-45	2.83 (7)	1.66 (5)
46-50	3.15 (4)	2.00 (3)
Average weight	2.77 (32)	1.88 (30)

**Table 6.** The diameter of pinealocytes at the beginning and end of pregnancy in relatively wild (1) and domesticated (2) foxes

Group	5-10 days		46-50 days	
	Diameter of dark nuclei, mmk	Diameter of light nuclei, mmk	Diameter of dark nuclei, mmk	Diameter of light nuclei, mmk
1	8.34 ± 0.56 (5)	11.36 ± 0.80 (5)	20.43 ± 3.78* (4)	29.66 ± 2.50* (4)
2	9.55 ± 0.39 (5)	9.70 ± 0.48 (5)	14.27 ± 2.40 (3)	28.19 ± 6.09* (3)

The lagging characteristics of pineal activity in the domesticated foxes "caught up" those in Gr. 1. This characteristic remains virtually the same in both groups during pregnancy, and there was a parallel increase in nuclear diameter of pinealocytes on days 46-50, evidencing enhancement of synthetic processes. It appears that pregnancy, as a specific period, has the most diverse compensatory mechanisms protecting embryos from changes in external and internal environments. In the domestic foxes there might have been some disturbances of the biological clock. Once occurring, they could be compensated by functional activity of the pineal.

#### *Age-related changes in pineal activity in female foxes*

Morphological analysis of the pineal in young females aged 8-9 months (November-beginning of December) demonstrated certain differences between aggressive and domesticated foxes already during

the period of sexual maturation. Thus, the difference in pineal weight observed for adults is also true for underyearlings (Table 7). Pineal weight in young tame foxes is much smaller, with the difference in weight being the same as in adults. The difference becomes prominent when the weight of the pineal is related to that of the body. the index for the amount of pineal tissue per unit of body weight is largest in aggressive underyearlings ( $62 \times 10^{-8}$ ) and lowest in tame adults ( $39 \times 10^{-8}$ ).

Linear density of pinealocytes, as an index of saturation of the organ with secretory elements, was the same in both groups and virtually did not change with age. Young foxes with different types of behaviour did not differ significantly in the ratio of the number of light to dark nuclei and the volume of the light, more active nuclei. However, these values were somewhat higher in the young tame foxes.

**Table 7.** Characteristics of the morphofunctional state of the pineal in aggressive (1) and domesticated (2) foxes at the age of 8-9 months

Group	Pineal weight, mg	Ratio of light to dark nuclei	Volume of light nuclei, arbitrary units
1	2.83 ± 0.16 (44)	1.5 ± 0.12 (9)	92.29 ± 4.05 (9)
2	1.92 ± 0.12* (41)	1.8 ± 0.23 (7)	103.92 ± 4.90 (7)

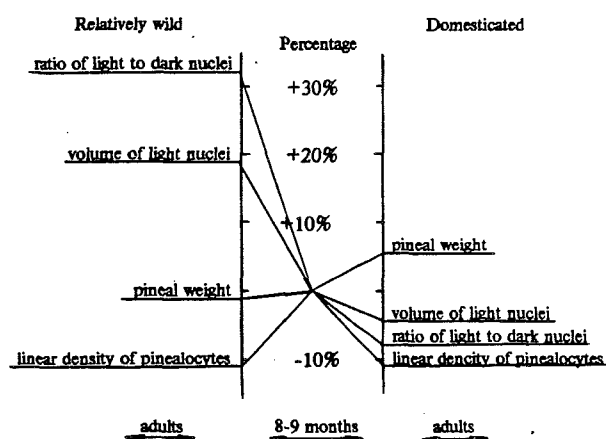
\*: the differences are significant by Student's t-test

We compared these characteristics of the functional state of the pineal in young and adult foxes previously involved in matings. The data evidence that they did not change significantly in the domesticated foxes. In the group of aggressive females the size and the number of the active light nuclei were significantly larger in adults.

This suggests that in foxes the pineal is already morphologically mature by the age of 8-9 months in terms of weight and density of parenchymous elements: their values reached those observed for adults. In adult aggressive females, the proportion of the more active light nuclei and their sizes increase at preparation to mating. No such signs of activation are noted in the domesticated females, as clearly shown in fig. 2.

No special study of the functional activity of the pineal was carried out in adults of different ages. The difference in the pineal weight registered at a young age persists for years (Table 8). This means that pineal weight is not so much dependent on age and phase of the sexual cycle, as on whether the population is domesticated or relatively wild.

There are data indicating that the pineal retains its high biochemical and secretory activity throughout maturity. It is functionally active to the age of 70 in humans (Wurtman *et al.*, 1964), and during adult life in rats (De Martino *et al.*, 1964). Our data also evidence for the morphological and functional constancy of the state of the pineal in foxes throughout the entire studied period (Kolesnikova *et al.*, 1988).



**Fig. 2.** Changes in indices of the pineal activity in relatively wild and domesticated adult foxes, expressed as percentage of estimates for 8--9 month old foxes.

#### *Morphofunctional state of the pineal in male foxes*

Like in females, the activity of the parenchyma of the pineal is not the same in males of the relatively wild and domesticated populations during sexual quiescence. Pineal weight is significantly smaller in Gr. 2 at the beginning of preparation to mating (Table 9). The relative proportion and sizes of cells of different types do not differ distinctly. The size of the dark, less active nuclei, remain the same. However, the light nuclei are much larger in domesticated males. Although small in number, their volume is larger.

**Table 8.** Pineal weight in relatively wild (1) and domesticated (2) foxes of different ages

1 year	2 years	3 years	4 years	5 years	Average weight
1 group 2.69 ± 0.18 (32)	2.56 ± 0.19 (11)	2.20 ± 0.32 (7)	2.57 ± 0.55 (3)	2.10 ± 0.46 (3)	2.72 ± 0.14 (56)
2 group 2.29 ± 0.14* (41)	1.91 ± 0.14 (20)	1.80 ± 0.20 (9)	2.23 ± 0.32 (3)		2.12 ± 0.09* (73)

\*: the differences are significant by Student's t-test

**Table 9.** Morphofunctional indices of pineal activity in relatively wild (1) and domesticated (2) male foxes at the beginning of preparation to mating

Group	Pineal weight, mg	Diameter of light nuclei, mmk	Relative volume of light nuclei, units/thousand	Number of light nuclei/pineal
1	2.91 ± 0.17 (22)	5.20 ± 0.64 (5)	74.8 ± 15.2 (5)	3134.36 ± 779.58 (5)
2	2.26 ± 0.19* (17)	7.16 ± 0.77 (5)	106.2 ± 12.6 (5)	1647.80 ± 480.18* (5)

\*: the differences are significant by Student's t-test

Thus, a distinctive feature of the pineal of domesticated males at the beginning or preparation to mating is the small number of cells with very large light nuclei, presumably, the synthetic processes intensely proceed in these nuclei. The two behavioural groups do not differ significantly in the number of granular inclusions, and, for this reason, it is difficult to suggest, which function dominates, secretory or accumulatory.

Seasonal changes in the state of pineal parenchyma were found to be similar in the two behavioural groups. At the onset of sexual quiescence signs of decrease in activity are distinct. In June, in the

relatively wild and domesticated males, when day-length is close to 18 hours, the relative volume of cells with light nuclei decreases as a result of increase in the number and volume of the less active types. The surface area and number of light nuclei decrease. The directionality and expression of most seasonal changes are almost the same in male foxes of the two behavioural groups (fig. 3). The only significant difference is an increase in the mass of cells containing secretory material in domestic males. It is  $182.2 \pm 53.3 \times 10^{-3}$  in June and  $66.0 \pm 17.0 \times 10^{-3}$  mg in November. The secretory function of the pineal seems to be more inhibited in domesticated males.

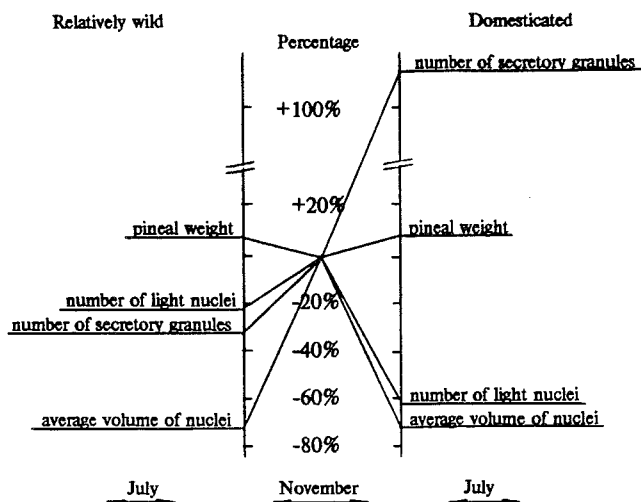


Fig. 3. Changes in indices of the pineal activity in relatively wild and domesticated male foxes in July as percentage of estimates obtained in November.

Based on the experimental data, the conclusions and suggestions concerning the fox pineal are as follows:

- the functional activity of the pineal in adult domesticated female foxes is decreased during preparation to mating. Because of the sharper changes in tame females, the groups level off by the time of estrous, becoming similar with that in the relatively wild during pregnancy;
- the changes in pineal reach a maximum in foxes showing the October form of extraseasonal sexual activation;
- the pineal is already morphologically formed at the age of 8-9 months. The activity of parenchyma rises with age in the relatively wild females, while it remains at the same level in the domesticated foxes;
- the characteristics of the morphological and functional state of the pineal of the relatively wild and domesticated males are different in autumn. However, these changes cannot be unambiguously accepted as signs of decrease in activity. The secretory function of the pineal is to a larger extent suppressed during sexual quiescence in males of the domesticated group.

Thus, selection for behaviour has led to changes in the key link of the mechanism providing strict seasonality of reproduction in foxes. Not only the

morphological and functional state of the pineal altered in domesticated males and females, but also the course of changes in its functional activity related to age, season and phase of the reproductive cycle.

It appears quite probably that the pineal, as an evolutionary plastic organ, when under strong pressure of selection for behaviour, can give rise not only to a wide range of physiological modifications, but also can supply genetic material for further transformation of sexual seasonality.

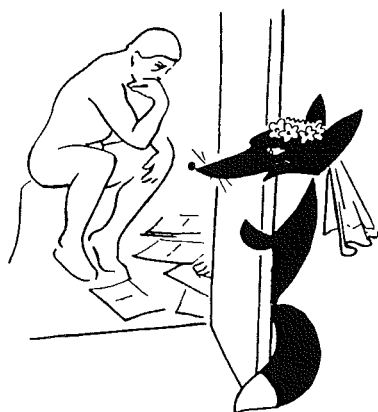
#### Acknowledgements

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*Original Report*

## Effect of environmental and social enrichment on some welfare variables in farm blue foxes (*Alopex lagopus*)

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### Abstract

Effect of environmental and social enrichment on growth, feed consumption, fear responses, space utilization, fur quality and reproduction was studied in juvenile farm blue foxes (*Alopex lagopus*). Altogether 16 males and 14 females were group-housed in a highly-enriched test house with free access to net and earthen floor sections. Equal number of animals kept singly in conventional farm cages served as controls. The results showed that fur quality and reproduction performance was poor in group-housed blue foxes, but good in controls. Individual variations in animal size were also large in group because dominant animals, being mostly males, tended to consume the feed portion of lower-ranking animals. Daily handling slightly increased number of curious animals, but the difference in temperament between handled (group-housed) and non-handled (single) animals was not very distinct. Animals spent most of their 24-h time on the net than on cage floor sections, indicating that they do not find net material unpleasant. Animals also preferred high places with an unobstructed view. The present test house fulfilled animals' needs for

rest, observation, seclusion, biting, and digging quite well. However, on the basis of the present production results, it is suggested that group-housing cannot be recommended for commercial farming purposes.

### Introduction

Environmental enrichment can be considered the addition of environmental features which enhance the complexity of the captive animal environment, resulting in beneficial effects on behaviour and other aspects of biological functioning (Newberry, 1994). Probably, an ideal environment for captive animals would be one in which behaviour falls within the behavioural range of their relatives in the wild, or, in the case of domesticated animals, semi-natural environments. Social enrichment is one means for increasing behavioural complexity in a natural direction by providing better access to mutual contacts among individual animals (Wichtmann, 1993; Korhonen & Alasuutari, 1995).

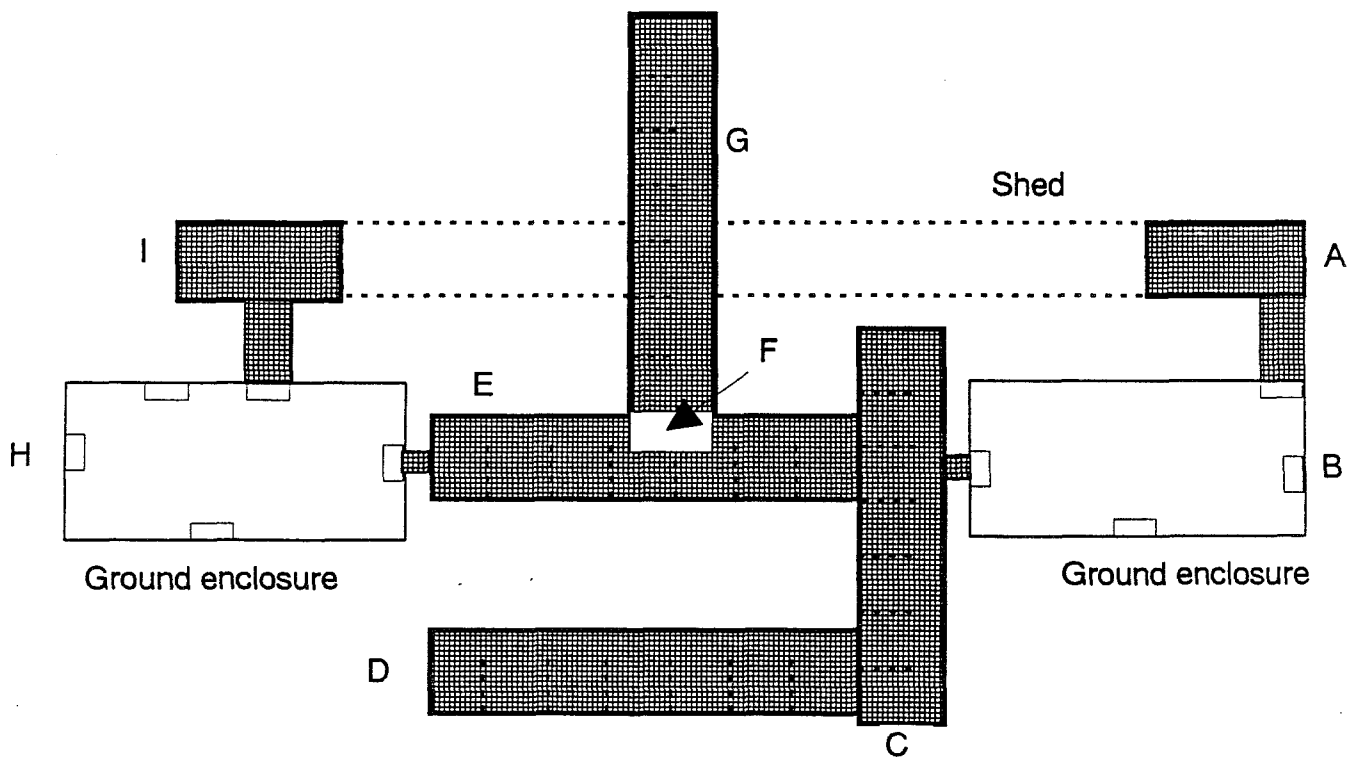
Interest in improved housing conditions in the husbandry of farmed fur animals has increased over

the last years. Consequently, recent ethological studies now often include the placement of resting platforms or nest boxes within cages (Jeppesen & Pedersen, 1990; Braastad, 1992; Harri et al., 1991; Korhonen & Niemelä, 1993, 1995; Mononen et al., 1993; Pedersen & Jeppesen, 1993; Rekilä et al., 1994) or housing animals in larger groups within semi-natural enclosures (Alasuutari & Korhonen, 1992; Korhonen & Alasuutari, 1994, 1995a).

Particularly results of cage furnishing experiments are promising. First, because the amounts of platform use have been generally high and second, because platforms have been found to function appropriately as a place for observing and rest (Korhonen & Niemelä, 1995a; Korhonen et al., 1995). In addition, Jeppesen & Pedersen, (1991, 1992) have found evidence suggesting that whole-year nest boxes promote stress reduction in silver foxes. Bakken et al. (1994) have further emphasized that farm foxes benefit from some kind of cage

furnishing, into which they can seek shelter when they are disturbed by humans or neighbours, and a place from where they can observe their surroundings.

The standing Committee of the European Convention on the Protection of Animals Kept for Farming Purposes has also set demands requiring more enriched housing conditions which would, for instance, ensure the possibility for expression of a wider variety of behaviour, increased opportunities for social interactions and possible contact with earthen floors (European Convention, 1991). Current recommendations also endorse the positive effects of handling and human presence on animal well-being. That concept has been supported in the results of recent studies showing a reduction in fear responses of silver foxes towards humans by early handling (Pedersen & Jeppesen, 1990; Pedersen, 1992, 1993a). However, further research will be needed before final conclusions can be drawn.



**Fig. 1.** Schematic diagram of the enriched test house construction. A-I are the main sections of the test house. A=shed cage, B=earthen floor enclosure, C,D and E are net floored cage sections, F=elevated part of tower, G=upper part of the tower crosswise the shed, H=ground floor enclosure, I=shed cage.

The present study was designed to expand the understanding on the effects of environmentally and socially enriched housing conditions (1) on the production parameters in juvenile farmbred blue foxes (*Alopex lagopus*). Therefore, development of body weight, feed consumption, fur quality, and whelping results were compared between enriched and non-enriched fox groups. A second aim (2) was to find out to what extent pronounced man-animal relationships, including daily handling, would affect temperament or fear responses of foxes housed in enriched conditions. Third, (3) the enriched test house provided us a possibility to compare foxes' preference between earthen and wire-mesh floors. Final purposes of above mentioned study aims was to find out to what extent enriched housing environment would advance animal welfare.

## Materials and methods

### *Construction of enriched test house*

The present experiments were carried out at the Fur Farming Research Station of Kannus in 1994-95. The enriched test house was built in summer (July) before weaning. A schematic diagram of the house is given in fig. 1. The enriched housing construction comprises 9 separate head sections. Section A was a conventional cage (180 cm wide x 110 cm long x 70 cm high) located inside the fox shed. A wire-mesh tunnel (30 cm wide x 100 cm long x 30 cm high) connected section A to section B which was an earthen floor enclosure (200 cm wide x 400 cm long x 180 cm high).

Three wooden nest boxes were placed inside this enclosure. The enclosure was connected by a wire-mesh tunnel to section C which was a large combination cage (159 cm wide x 525 cm long x 70 cm high) made of wire mesh construction. Height of the combination cage from the ground was 80 cm and it contained 7 smaller sections (107 cm wide x 75 cm long x 70 cm high each). Foxes had a free access to each of the following: (1) a nest box, 70 cm long x 40 cm wide x 40 cm high, (2) a triangular, flat corner wooden platform; 65 cm x 91 cm, (3) a large, V type wooden platform; 103 cm long x 30 cm wide, (4) a small, V type wooden platform; 52 cm long x 30 cm wide, (5) an empty cage without enrichments, (6) a small wire-mesh net platform; 52 cm long x 30 cm wide, (7) a large, wire mesh net platform; 103 cm long x 30 cm wide.

Ceiling height was 23 cm from the cage roof throughout. For further details see Korhonen & Niemelä (1994a). Section C provided access to sections D and E which were similar to C, except section D had neither nest boxes nor platforms. Section E accessed section F which was a 240 cm high tower (110 cm wide x 70 cm long). Tower F comprised three platforms at various heights from the floor level as follows: 70 cm, 110 cm and 190 cm. From the top of tower a 240 cm long cage G (110 cm wide x 70 cm high) ran horizontally along the roof of the shed. This cage was equipped with two platforms.

From the other end of section E there was an access to ground enclosure H which was identical to enclosure B. Section H had a tunnel connection to section I which was a conventional shed cage (similar to section A). Wooden whelping nest boxes were introduced into the test cage system before the breeding season in February. Five top nest boxes (70 cm long x 40 cm wide x 35 cm high) were placed in section D and one in sections I and A each. One bottom nest box (70 cm long x 40 cm wide x 40 cm high) was also placed in sections I, E and A. In addition, four bottom boxes were located in sections B and H.

### *Experimental animals*

The experiments began on July 18th when 16 male and 14 female blue fox kits were placed inside the enriched test house. A control group also included 16 males and 14 females each placed singly inside conventional farm cages (110 cm long x 60 cm wide x 70 cm high) within the shed. Litters were divided half to both experimental and control groups. In November, the animals were pelted. Only three males and 6 females were left alive to continue breeding.

### *Measurements*

Testing of animal's human fear response was made as follows: each animal was placed inside a separate cage (60 cm long x 40 cm wide x 40 cm high) for 1 min. After that, the cage door was opened and the experimenter reached for the fox. The test based on the following reaction, body posture and ear position (Fox, 1970; Pedersen & Jeppesen, 1990). The animals were classified either (1) curious or (2) non-curious. The experimental animals were handled 5 days a week for 10 min/day by three different



persons on successive days as follows. The handler entered section B, sat on a small chair and waited until the animals (or some of them) approached. Thereafter, these animals were fondled and the handler also talked to them. The number of animals that approached and escaped to the tower was calculated for each handling day.

Amounts of given and left fed were weighed daily to calculate consumption. Body weights were measured three times during the experiments. Space utilization of breeding animals (3 males, 6 females) was recorded by video camera equipment (CCD camera 7240, time lapse tape recorded Bische UB-480, Koyo monitor, Bische 12-300 infrared light, 500W). Video recordings, over a 5-day period, were made in February. Because the test house was so large, it was impossible to videorecord all of its sections at the same time. Thus, the recordings were made section by section. As a consequence of this, we were not able to have quite accurate results of the total use.

However, our analysis revealed that recordings do provide a fairly good overview of the situation. Furthermore, the results were corrected to be proportional to 1440 min/day.

#### Statistical analysis

The data were analyzed by the General Linear Model (GLM) procedure of SAS. The comparisons between the groups were performed using Tukey's Studentized Range (HSD) test.

#### Results

##### Weight development

The test animals were weighed for the first time on September 7th (Table 1). Females from enriched test house were then found to be significantly lighter than female controls. A parallel difference was found in the other weighings also. In males, on the other hand, no statistically significant differences were detected between experimental and control groups.

**Table 1.** Comparison of body weights (kg; mean  $\pm$  SD) between group-housed and control (single) blue foxes. Means with different superscripts are significantly different. Sept 7th: a>b, p<0.05. Sept 27th: a>b, p<0.01. Oct 25th: a>b, p<0.001. a>c, p<0.01. d>c, p<0.05. d>b, p<0.01, a=d

Date	Group-housed		Controls	
	Males	Females	Males	Females
Sept 7th	5.9 $\pm$ 0.7a	4.7 $\pm$ 0.3b	5.9 $\pm$ 0.5a	5.5 $\pm$ 0.3a
Sept 27th	7.4 $\pm$ 0.9a	6.0 $\pm$ 0.6b	7.4 $\pm$ 0.9a	6.9 $\pm$ 0.5a
Oct 25th	9.8 $\pm$ 1.4a	7.5 $\pm$ 0.7b	9.3 $\pm$ 1.1ad	8.4 $\pm$ 0.7c

**Table 2.** Comparison of feed consumption (g/animal/day; mean  $\pm$  SE) between group-housed and control animals. Feed portions of group-housed foxes are only calculated values because in reality they were divided by the group members so that the actual amount eaten per fox is unknown. Values of the control animals are the actual individual amounts

Period	Group-housed	Controls
Aug 8th-Sept 7th	683 $\pm$ 54	665 $\pm$ 15
Sept 6th-Sept 27th	971 $\pm$ 62	850 $\pm$ 59
Sept 28th-Oct 26th	718 $\pm$ 42	715 $\pm$ 36
Total mean	798 $\pm$ 34	752 $\pm$ 28

**Table 3.** Number of curious and non-curious animals

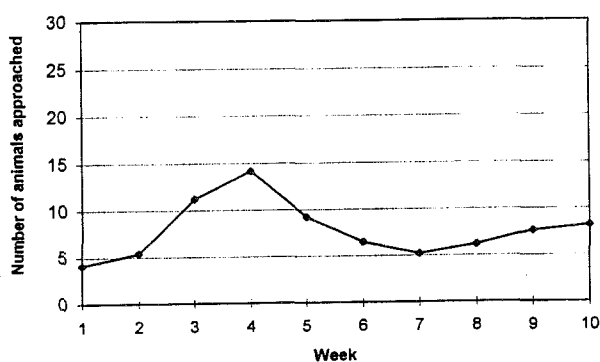
Date	Curious		Non-curious	
	Group-housed	Controls	Group-housed	Controls
Sept 7th	13	9	15	21
Sept 27th	14	15	14	15
Oct 25th	20	16	8	14
Change	+7	+7	-7	-7

*Feed consumption*

Because the animals in the enriched test house were reared in group, they have to be fed higher feed rations than controls (housed singly) to ensure that all animals received feed. Thus, also the feed consumption of experimental animals tended to be higher than that of controls (Table 2). Average feed consumption of animals of the former group was about 50 g/animal/day more.

*Fear responses*

Fear responses of the animals were first tested on September 7th. This testing episode revealed that there were 13 and 9 curious animals in experimental and control groups, respectively (Table 3). During the second testing one additional control animal was classified as curious. The final fear test on October 25th showed 20 animals were curious in the experimental and 16 in the control groups. In both study groups, the number of curious animals increased as much (change +7) during the experimental period.



**Fig. 2.** Number of foxes that approached experimental handlers. Data are presented as mean number of animals/week.

*Effect of handling*

Response of foxes to our three handlers differed (Table 4). The foxes were most trustful of handler number 3 (on average 9.8 foxes/handling session approached handler) and least trustful towards handler number 2 (6.4 foxes/handling session approached handler). The results was also parallel concerning foxes that dared to make very close contacts with the handler, for instance, by nibbling the shoes and trousers of the handler. The number of foxes that approached the handler progressively increased, being highest at 4 weeks (14 foxes/handling session approached handler). Thereafter, however, the number of animals decreased, and reached a plateau (5-8 foxes/handling session approached handler). Four foxes (1 male, 3 females) were very "human-attractive", as they approached the handler in over 75% of the handling sessions. On the other hand, only 13 foxes approached the handler in over 25% of the handling sessions.

*Fur quality*

Fur quality of skins was professionally evaluated after pelting by dividing skins into the following categories: (1) poor skins (Finnish Fur Sales' auction category III), and (2) the others. It appeared that the skins of foxes from the enriched test house were poor and thus all classified into the category III (1). None of the control skins were poor in quality.

*Space utilization*

The tower was them most favoured section (F + G) where the animals spent almost half of their circadian 24 h (Table 5). The next popular section was cage section I in the fox shed.

**Table 4.** Mean number of animals that approached, made physical contact with handler or escaped to tower in the presence of experimental handlers

Variable	Handler 1	Handler 2	Handler 3
Approached	8.2	6.4	9.8
Physical contact	3.9	3.7	4.7
Escaped to tower	12.6	9.6	11.8

Of the two earthen floor enclosures, H section was preferred by the foxes. Total time spent on ground surfaces was only 11% of the total space utilization of the test house. Circadian distribution for spatial utilization in the three most popular sections is shown in Fig. 3. The animals spent less of their 24-h period in the tower during working hours than after them. The reverse was true in the earthen floor enclosure H and cage section I.

**Table 5.** Average circadian time (min/24 h  $\pm$  SE) a fox spent at the different sections of the enriched test house. Data are based on continuous 5-day video recordings. For the sections see Fig. 1.

Section	Spent time
Ground enclosure H	126 $\pm$ 10
Ground enclosure B	61 $\pm$ 6
Cage I	543 $\pm$ 93
Tower F + G	692 $\pm$ 54
Other sections	18 $\pm$ 2

#### Whelping result

Some aggressive encounters including leg bitings were observed as the breeding season approached. The condition of one male was so poor that it had to be removed from the test in late March. Two females out of the total six whelped. The first female delivered 8 kits on May 13th inside the top nest box in section D. The other female whelped 9 kits on May 26th inside top nest box of cage section I. Both females transferred their kits almost daily from one nest box to another throughout the test house. After two weeks, all the kits of female 1 was dead and only three kits of female 2 survived until the age of weaning. Occasionally, a third female was observed to assist in nursing. She spent periods

of varying duration together with the biological mother and kits inside the whelping nest box. On the other hand, some other test animals (both males, and females) were occasionally observed to disturb the lactating females.

Whelping of the controls succeeded normally, and the whelping result was 7.9 kits/female.

#### Discussion

The present study sought to evaluate the effect of a highly-enriched group-housing arrangement on some essential parameters which can be considered indicative of welfare in the farm fox. It is known fact that the estimation of an animal's welfare is complex. Several sound physiological and behavioural parameters have been employed for welfare evaluation, also in the case of farmed foxes (*Pedersen, 1993b; Jeppesen, 1994; Rekilä et al., 1994*). In the present study, we concentrated on the measurements of growth, feed consumption, fur quality, reproductive performance, fearfulness and space utilization. Although these crucial parameters cannot be extrapolated to cover all aspects of animal welfare, we suggest that the present results provide a relatively good overview of the situation (*Korhonen, 1994*). Most of the variables that were presently used, are often considered mainly as productive parameters. However, they would also include marked signals from the point of animal welfare (*Braastad, 1992; Korhonen & Niemelä, 1993; Bakken et al., 1994*).

Body growth data clearly showed that rearing foxes in group easily leads to marked body size variation among the group members. Weaker individuals, i.e. mainly females, do not receive enough feed because stronger ones (males) dominate the feeding situation. Previous experiments (*Korhonen & Alasuutari,*

1994, 1995) in group-housed arctic blue foxes housed in large earthen floor enclosures have provided parallel results. Further, the present results permit us to suppose that although animals in groups would be received higher than normal feed rations, males at the top of hierarchical order might even prevent some lower-ranking females from

eating. For instance, we noticed that sometimes feed was left on the feeding trays but, nevertheless, some group-housed females did not attempt to eat it. In conventional farm cages, in which animals are fed singly, they do not face above mentioned problems. Our weight data revealed that also the growth of control females in farm cages was normal.

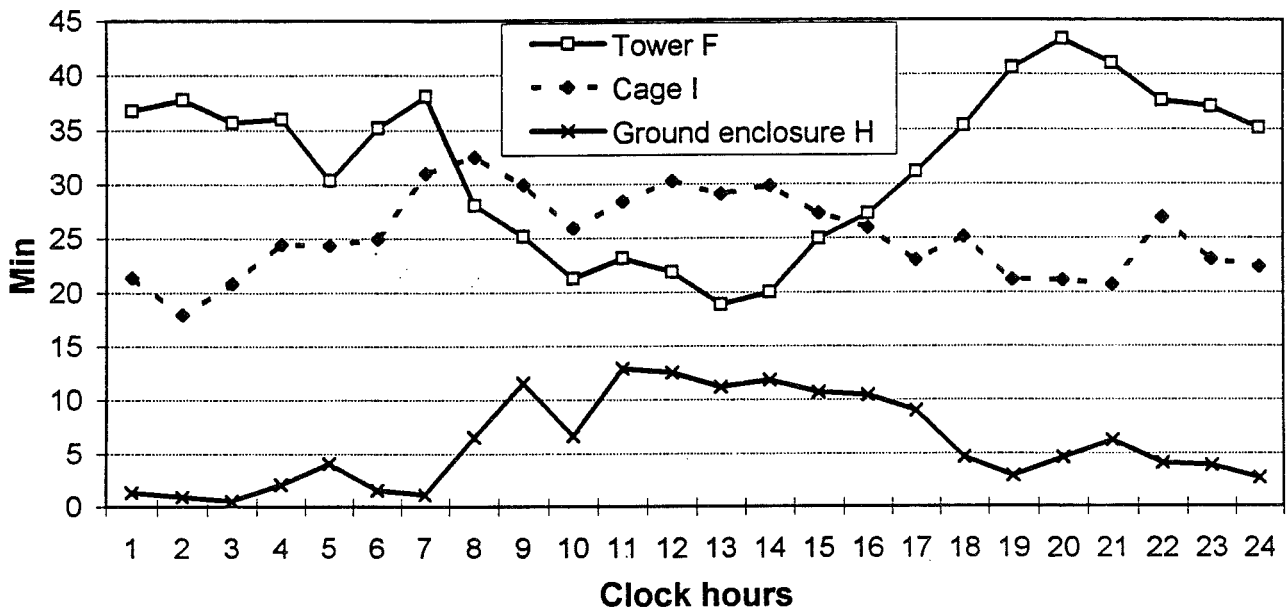


Fig. 3. Circadian distribution of time (min/h) animals spent on the three most favoured sections of the enriched test house.

Our final fear test showed that there were 4 animals more which were curious in handled group compared to non-handled one. This can be considered as an indication that handling affected positively on character of our blue foxes. Early handling, from 2 to 8 weeks of age, has been found to have a positive effect on the welfare in silver foxes by reducing their fear responses towards humans (Pedersen & Jeppesen, 1990; Pedersen, 1992). In the present study, handling sessions were started not before mid-August, i.e. animals were older than in previous silver fox experiments. This partly explain why difference in fear response between handled and non-handled animals was not so distinct. Second, it is very likely that handling is not as significant for animals housed in groups because some of the group-housed animals attempt to avoid handler. The animals in the experiments of Pedersen & Jeppesen

(1990, 1992) were more easy to handle individually because they were housed only in pairs inside conventional farm cages. Furthermore, also group-housing and handling together may have some interactive effects, either positive or even negative, on welfare and temperament of animals (Hubrecht, 1993).

Further research will be needed in order to clarify this hypothesis.

Handler number 2 was the least attractive to the foxes as the number of foxes that approached in her presence was the lowest. However, a very interesting finding was that the number of foxes that escaped up to the tower was also the least in the presence of handler number 2. Thus, it is tempting to conclude that handler number 2 probably was the

most neutral person of our three handlers. Possibly some individuals cause stronger reactions among foxes than others. Probably the most neutral individuals are also the most disturbing from the foxes point of view.

Reproductive success in our enriched test house was poor. The result was very comparable to that obtained from large ground enclosure experiments in which only few females normally become pregnant or whelped (Korhonen & Alasuutari, 1994, 1995). This is due to the pronounced social tension characteristic of the dominance hierarchy of group-housed blue foxes which effectively prevents most females from breeding (Korhonen & Alasuutari,

1995). Social conflicts and disturbances by other individuals were probably the fundamental reason for the high kit losses of our lactating females also, as has been the outcome in previous group-housing experiments (Korhonen & Alasuutari, 1994, 1995).

Main goal of commercial fur farming is to produce furs with high quality. To a certain extent, the quality of furs can be considered also as an indication of animal welfare (Korhonen & Niemelä, 1993; Korhonen, 1994). Our present study clearly showed that group-housing in highly-enriched test house significantly decreased fur quality of the animals. Correspondingly, Hubrecht (1993) have found that socialization with enriched pens can lead to the development of coat and skin problems in laboratory dogs. Therefore, such kind of enrichments may have questionable or marginal value for animal welfare.

In light of the present video results, it is clear that net flooring can not be considered a poor surface for farmed foxes, as the test animals spent most of their day in cage sections with net flooring. This finding is in good agreement with that of our previous preference experiment (Korhonen & Niemelä, 1994b) in which foxes were also found to use significantly net flooring. Furthermore, it appears obvious that foxes do have a preference for higher places from which they may effectively survey their surroundings, as reflected the popularity of the tower. Moreover, the second most popular section, i.e. cage I, was similarly located in an elevated location offering unobstructed view. Previous experiments made in conventional farm cages

also support the significance of observing possibility (Mononen *et al.*, 199; Korhonen & Niemelä, 1995; Harri *et al.*, 1995).

It is known that also in the wild, foxes choose to sleep and rest on elevated places such as logs or boulders outside their dens (Tembrock, 1957).

The recommendations of the European Convention (1991) imply that needs for rest, observation and seclusion should be satisfied in order to enhance welfare of farmed foxes. According to the present results, it is obvious that the presently studied test house fulfils these needs well. Our test system also provides good facilities for such important needs of dog-like animals as biting and digging. The complexity of the test house also should provide the fox with better possibilities to behave in a manner

appropriate for the species (Korhonen & Niemelä, 1994b). On the other hand, Hubrecht (1993) have noticed in dogs that appropriate enrichment can increase the complexity of dog behaviour but, however, it is not necessarily easy to assess the welfare implications of the changes. The same problem apply with respect to the present results. In conclusion, the present and previous results (Korhonen & Alasuutari, 1994, 1995) support the concept that group-housing cannot be considered suitable for commercial fur production particularly due to the poor breeding success and deteriorated fur quality observed. However, the facts that enriched test house can satisfy the animals' needs for rest, observation, hiding, digging and biting (European Convention, 1991) are positive indications of welfare implications.

#### Acknowledgements

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Original Report

## Ethological examination of breeding chinchillas (*Chinchilla lanigera*)

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### Summary

The authors monitored the ethological features displayed by nursing chinchilla females (n=3), of non nursing breeding females (n=3) and of breeding males (n=2). Observation was done at 1, 10, 20, 30, 40, 50 and 60 days of age. The 24 hours of the day were divided into four 6-hour intervals, two in the daytime, the other two at night. Behaviour elements to be observed were: resting, pressing close together, movement, cleaning themselves, scouring, eating, drinking, cecotrophy and suckling. Suckling frequency, in the period from 1-50 days: every 1, 2, 3, 4, 3 and 8 hours, on the 60th day there was no suckling at all. Cecotrophy occurred only in the daytime. The authors make proposals with respect to scheduling the care of chinchillas.

### Introduction

Under the environmental conditions that have been created by man it is primarily behaviour through which animals are able to express their general feeling. By observing their behavioral indications important information can be obtained, whether the environmental circumstances meet the requirements of an animal or a group of animals. In the recent past several studies have been made on the behav-

our of carnivorous fur animals (*Braastad, 1992, 1994; Braastad and Bakken, 1993; Korhonen, 1994*) with the aim of striving for animal welfare. Also, some comprehensive studies have been prepared (*Bakken et al., 1994*).

Our knowledge with respect to the behaviour of tame chinchillas is insufficient or contradictory in several fields: the publications deal with very limited numbers of behaviour elements at a time (*Anon., 1986*). We can mention the observations made on fur chewing (*Tóth, 1987*) and growing (*Györpál, 1994*) animals. Based on all this, our objective was to examine the ethology of nursing females (who nursed young of various ages), non-nursing females and breeding males under standardised environmental circumstances.

### Material and method

The investigations were performed using the chinchilla flock maintained at the Experimental Station of the Faculty of Animal Breeding at Kaposvár. The breeding chinchillas were accommodated in bedded cages arranged in 3 floors in a closed barn fitted with windows and heated in winter. The basic area of the room was 37 m<sup>2</sup>. The relative humidity fell between 50 and 60 %, and the temperature was

17-18 °C (23-25 °C in summer) inside the barn. The dimensions of the cages were: 0.35 m x 0.60 m basic area and 0.38 m height. The animals were bred in the traditional system of polygamy; the males had free access to the females throughout the year, except for the suckling period. The young chinchillas were weaned when they were 56 to 60 days old. The ration consisted of a commercial chinchilla pellet and water ad libitum. Grass hay was provided every other day.

The ethological observations were made around the clock at natural lighting in the daytime and using a weak (40 W), artificial, blue illumination at night. The behaviour elements to be observed were grouped as follows (Széky, 1979; Csizmadia, 1991). The heading "resting" included separate observations of sleeping, lying, sitting and sitting on 2 feet. Quiet movement and fast movement were recorded as "movement". The behaviour elements concerning metabolism, such as eating pellets, hay and bedding material were considered as one, and they were defined as "eating". "Cecotrophy" and "drinking" were taken into account separately. Suckling frequency was measured among the reproductive behaviour elements.

Behaviour of the nursing females was examined at the following times: on the day of delivery (the observations were started within 24 hours after birth) and 10, 20, 30, 40, 50 and 60 days after delivery. On one occasion (24 hours) several nursing females were observed simultaneously. Namely, we decided to observe every individual 2 times per hour for 5 minutes instead of observing one animal for 24 hours. The non-nursing females and the males were observed for 5 minutes, too, but only once in an hour (in due course). We put in 5 minutes rest in every half hour; this way the behaviour of 5 animals could be followed and recorded.

The 24 hours of the day were divided into four 6-hour intervals, two in the daytime and two at night (the observations at the end of autumn). The following numbers of individuals were examined: 3 nursing, 2 non-nursing, 1 pregnant female and 2 breeding males.

For the evaluations the behaviour elements were expressed as percentages. The exceptions were the elements of "nursing" and "cecotrophy": in these cases the frequencies of occurrence were indicated.

This way we could calculate the ratios and frequencies of the behaviour elements and the relations of these in different parts of the day. The total of the percentages exceeds 100 % due to the fact that more than one behaviour element was observable at a time, e. g. "pressing close together" during "resting", etc.

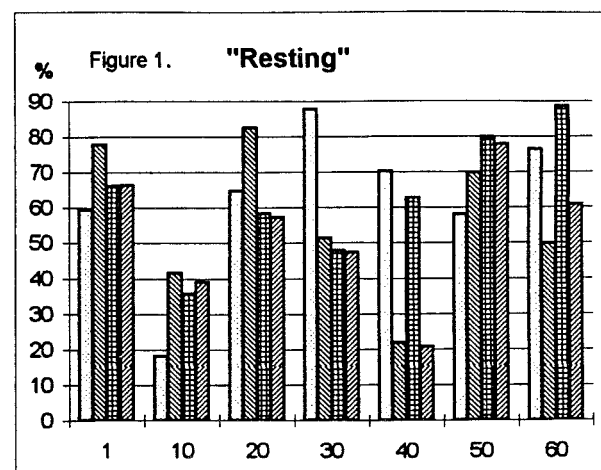
## Results and discussion

### I. Results of the observation of nursing females

#### 1. Inactive behaviour elements

##### 1.1. Resting

Resting represented the biggest ratio out of the daily activity of the nursing females in every case (table 1 and figure 1). Concerning the females with day-old young, the resting time was longest during the early afternoon hours, but was fairly even throughout the day. In the case of females nursing 10-day olds the time of resting was surprisingly short, i.e. app. 20 to 40 % in the single time intervals; it was shortest in the morning hours (before noon). The females nursing 20- and 30-day olds spent rested as much time as the ones that were nursing day-olds. A huge fluctuation was observed on the 40th day among the values for various parts of the day; the animals had the longest rest periods in the morning and at night (from 7 p.m. to 1 a.m.). By the 60th day of nursing the daily routine changed. Contrary to what is generally believed, the animals spent, although slightly, more time resting in the night than in the daytime.

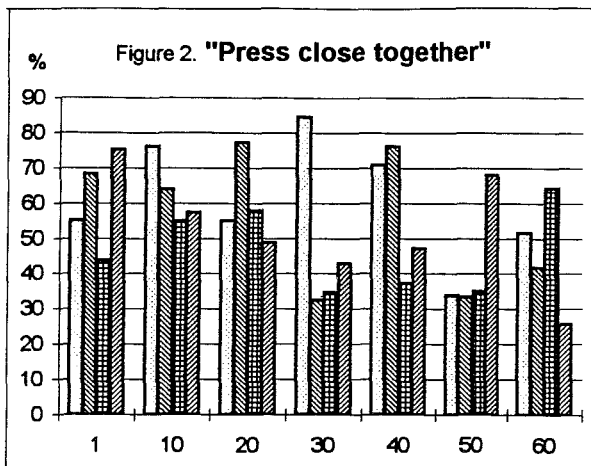




1.2. Pressing close together

The role of this kind of behaviour is to warm the young progeny and maintain the contact between mother and progeny. It is usually the young who snuggle up to the mother. While being pressed together, the mother can have a rest. Eating, scouring and nursing may occur simultaneously. This latter behaviour represents the second highest ratio after resting.

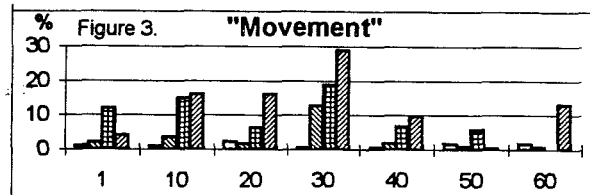
Observing the behaviour of the mothers nursing progeny of various ages (table 1 and figure 2) it can be established that the mothers pressed close together with their babies in the daytime rather than at night. It was also observable that this kind of behaviour occurred most evenly and at highest ratio in the case of the mothers nursing 1-20-day olds, and the time spent with this kind of behaviour decreased with increasing age and agility of the young chinchillas.



2. Active behaviour elements

2.1. Movement

The active period of chinchillas is at night. It is mostly during the evening and night hours that they move (table 1 and figure 3). Figure 3 shows that the time spent with movement increases until the 30th day, then a tendency of decline is characteristic. The probable explanation is that at the beginning the mothers spend more time eating and searching for food. At the same time, the young chinchillas suckle more times, and the mothers have more rest (the exception is the 20th day) and spend more time pressed close to their offspring. As the young start eating a solid diet and start drinking water from the 20th day on, they disturb their mothers less and less by the intention of suckling, and so, the movement of the mothers drops, too.

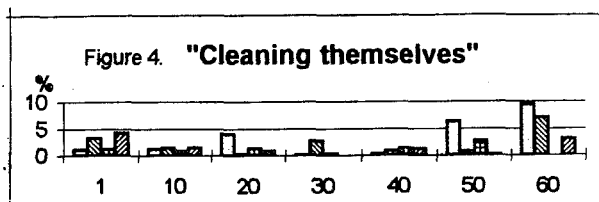


2.2. Cleaning themselves

This kind of behaviour can be described as wiping the head from the back ahead with the front legs or cleaning the paws and hair by the mouth. Scratching, usually around the ears, also occurs. The real duration of cleaning (figure 4) as a behaviour element is hard to determine. Quite often, it takes only some seconds, and is not associated with any part of the day.

**Table 1.** Development of some important behaviour elements according to the daily activity

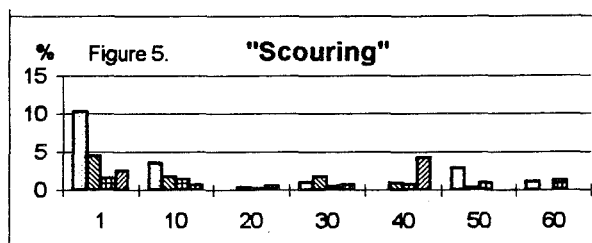
Behaviour elements	Age of youngs (days)						
	1	10	20	30	40	50	60
	Ratio of the daily activity (%)						
Resting	67.5	33.6	65.8	58.6	43.9	71.4	68.9
Pressing close together	60.6	63.1	59.8	48.6	57.9	42.5	45.8
Movement	4.8	8.9	6.7	15.2	4.7	2.2	3.9
Eating	11.6	13.4	21.5	16.6	10.5	15.2	15.1



On the first day the mother spends more time cleaning herself (2.5 %), and scouring the newborn chinchillas. The ratio of cleaning herself becomes app. 1 % between the ages of 10 and 40 days of the progeny. Towards weaning age the young take more care of cleaning themselves, and they participate in the cleaning of their mothers, too (this behaviour helps in keeping up the contact between them). The ratio of cleaning themselves becomes more elevated in case of the mothers, too, i.e. 2.4 % and 4.9 % by the 50th and 60th day, respectively.

2.3. Scouring

This behaviour element is very frequent, and has a social function in addition to simple body care. Our observations underline that 1 and 10 day old chinchillas scoured for the longest time (4.7 % and 1.9 %, resp.); scouring the offspring mostly occurs in the daytime (figure 5). At older ages the young are already self-supporting, so the time spent with scouring them becomes reduced.



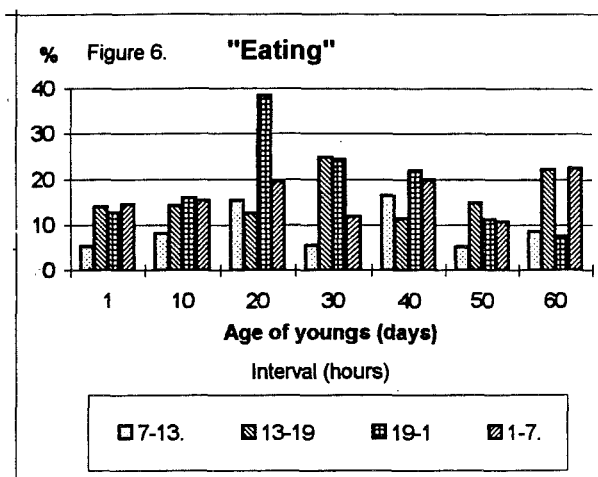
3. Behaviour elements relating to metabolism

3.1. Eating

Chinchillas prove an outstanding manual ability in this respect. They usually use their front legs for grabbing the food and for forwarding it to their mouth. Then, they nibble the bite with a fast and small masticating motion characteristic of rodents.

The time spent eating increased parallelly with milk production until the 20th day (table 1 and figure 6). It decreased as the animals started consuming a solid diet. The chinchillas ate mainly in the evening

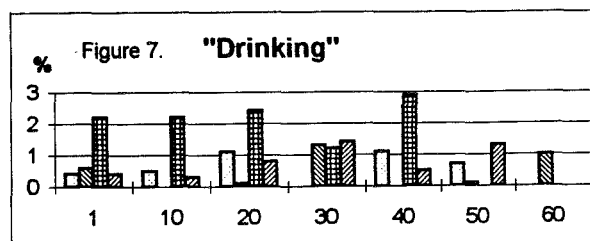
hours, which was positively associated with movement and negatively with resting. All this can be traced back to the active life of chinchillas at night.



3.2. Drinking

The chinchilla does not require much water to drink, so this behaviour element is scarcely observable and only for a short time. Knowing the usual times of drinking is of practical importance from the point of view of vitamin and drug administration.

The time spent drinking shows a very varied picture as compared to the daily activities (figure 7). The females nursing 1 to 30 day old progeny spent 1 % of the day drinking water. The animals drank during the night hours (from 7 p.m. to 1 a.m.) Drinking became irregular by the 50th day, and it amounted to a very low ratio by the 60th day due to the reduced number of sucklings (0.5 % and 0.3 %, resp.).



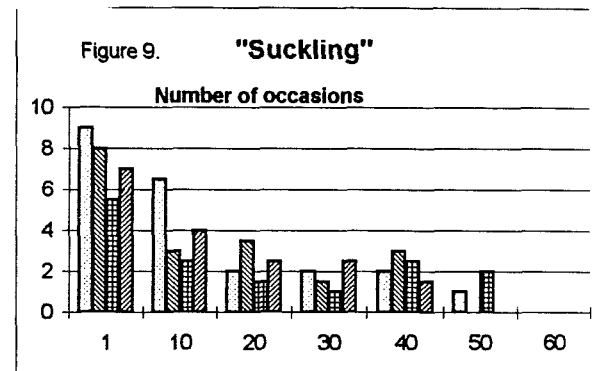
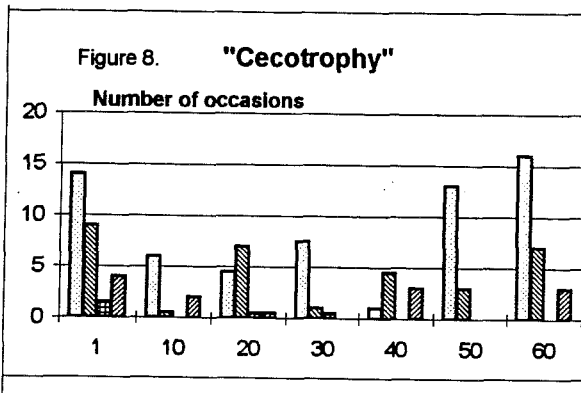
3.3. Voiding

Voiding occurs in attachment to other behaviour elements, and can't be characterised with a typical body position. Therefore, these behaviour elements were not observed in the course of the investigations.

**3.4. Cecotrophy**

After a shorter or longer resting period the chinchilla bends forward quickly, humpbacking, and takes excrement by the mouth out of the anus. Then, standing straight again, it produces some motion with the mouth, similar to chewing, but in reality, it swallows the matter without chewing it. It repeats eating cecotrophs several times. In contrast to the rabbit, the chinchilla performs cecotrophy mainly in the daytime and not in the night or dawn hours (figure 8).

suckling. The duration of nursing cannot be measured precisely. What can be measured is its frequency (figure 9). According to our observations the females nursed every hour on the day of delivery without any differences among the parts of the day. When the progeny were 10 days old, the mothers nursed every other hour on average, but there were significant differences among the parts of the day. Similarly to the later stages, nursing was more typical in the daytime. On average, the females nursed every 3 hours on the 20th day, every 4, 3 and 8 hours on the 30th, 40th and 50th day at all.



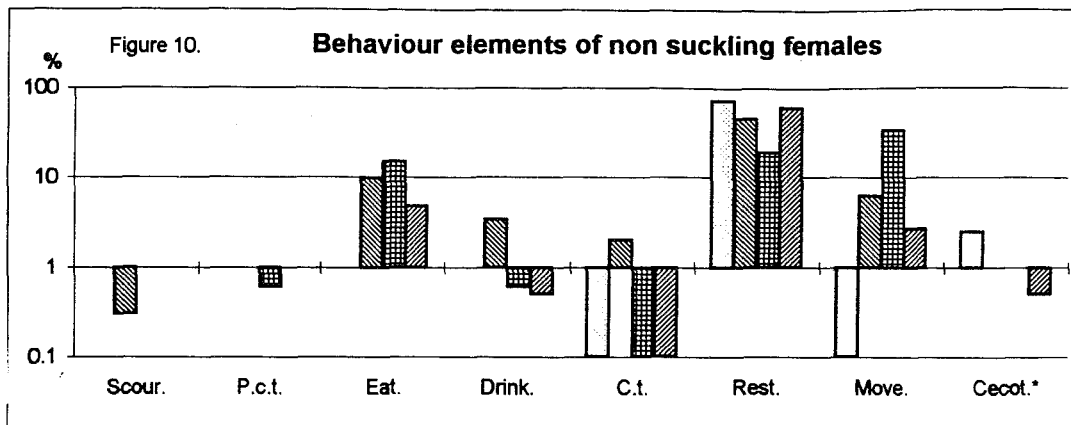
**4. Reproduction related behaviour elements**

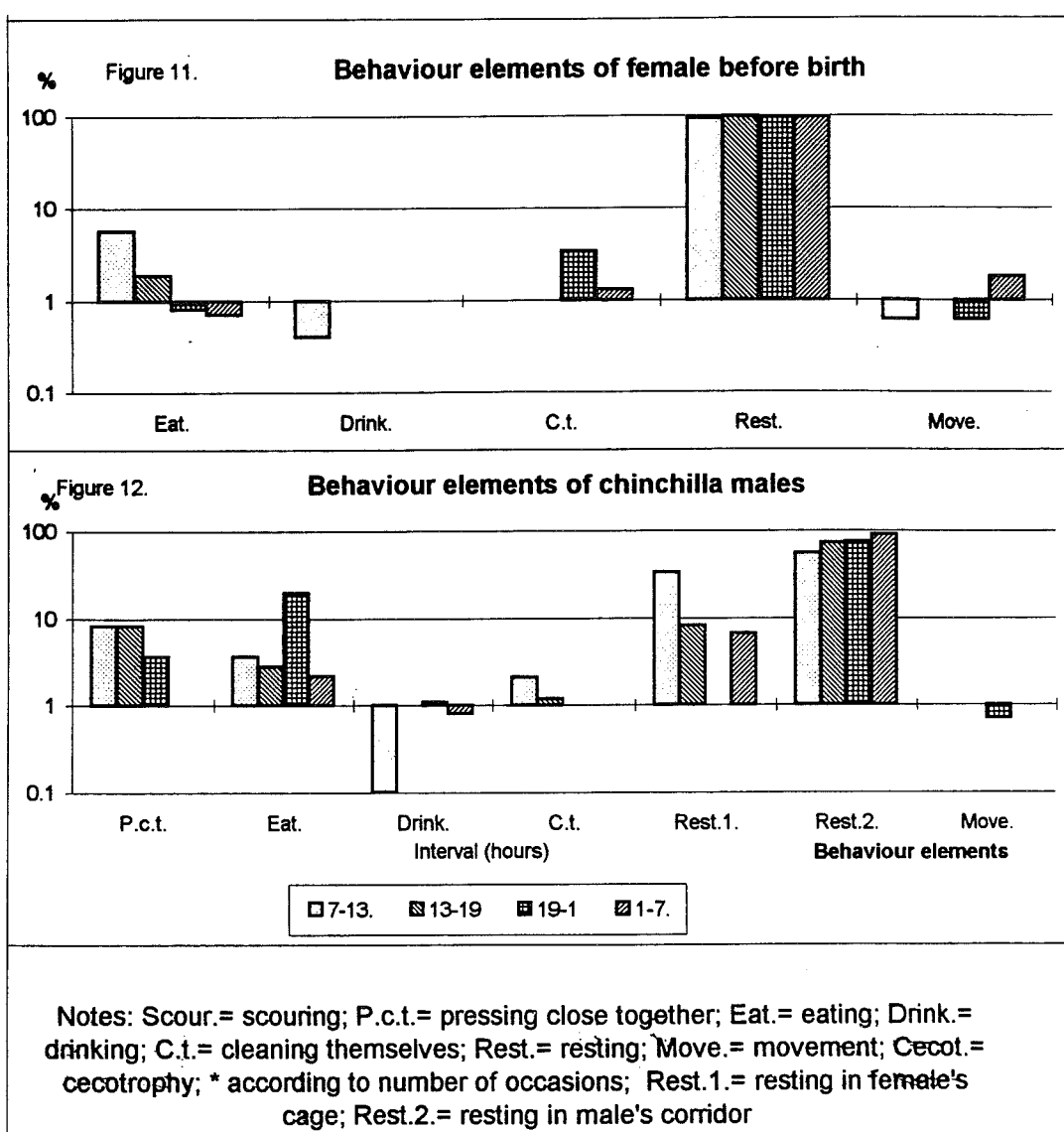
**Behaviour elements of nursing chinchilla females**

**4.1. Nursing**

The chinchilla mother nurses in a half-squatting body position, sitting on the hind legs and leaning by the front legs. The young suckle lying on their backs or sitting on their 4 feet in a resting position. Occasionally, they produce a low sound during

By 6 weeks of age the growing chinchillas have turned to consuming a solid diet (pellet and hay) and to drinking water. From this stage on the importance of breast-milk drops considerably and finally ceases. According to our observations, the 50 day old chinchillas suckle very few times and the 60 day old ones don't suckle at all any more.





If the mother's state of health makes it possible, the young (growing) animals can be weaned before the age of 8 weeks.

**4.2. Mating**

The male has access to the non-nursing females and to the fresh mothers for 1 to 2 days after delivery. Mounting after delivery does not endanger the progeny if the breeding pair are accustomed to each other. The copulation takes only some seconds (Anon., 1992). In the course of the examinations mating could be observed only one time: in the case of a fresh mother, at early dawn (between 1 and 2 o'clock a.m.).

**II. Results of the observation of non-nursing females**

Similarly to the nursing females, the non-nursing ones spent a large part of the day resting, i.e. 49.2 % of the daily activities. The authors applied a logarithmic depiction (figure 10) in order to make the results of the observations clearer for the reader. The behaviour element groups of "eating" and "movement" had similar ratios of occurrence, and they showed the highest percentages in the afternoon hours (7.45 % eating and 10.65 % movement within the total daily activity).

The time intervals were the same for drinking and eating. The individuals observed produced cecotrophy 3 times daily on the average, which occurred in the morning and at early dawn. The animals spent a short time scouring the male and pressing close to the male, which arose from the fact that the males spent two-thirds of the day in the male's corridor; they entered the females' cages particularly in the night. There was one occasion when we could observe the behaviour of the female just before delivery. The carrying females moves with difficulty, and she spends the overwhelming part of the day resting (95.7 %, figure 11). Consequently, the ratio of movement was as low as 1 to 2 %, and movement occurred mostly during the night hours and drinking only in the morning. She spent 2.3 % of the day eating, almost exclusively in the daytime.

### III. Results of the observation of males

The males spent 65.6 % of the day resting in the male's corridor (figure 12). They spent only 12.1 % of the time in the cages of the females. Inside the female's cage the male strove to stay close to the female: they pressed close together and had a rest together several times. The males observed spent 7.2 % of the time eating, mostly at night. Drinking and cleaning themselves took a short time, mostly in the morning hours. Movement occurred mainly in the evening but the ratio was very small (some tenth percentages) in spite of the fact that the males had a rather large area for this kind of activity (basic area of the male's corridor + cages of the 1-4 females).

### Conclusions

Considering the results of the investigations the following conclusions can be drawn with respect to the most important behaviour elements:

The frequency of nursing showed the following tendency in the case of mothers nursing progeny of various ages: every hour on the first day, every 2nd, 3rd and 4th hour on the 10th, 20th and 30th day, resp.. The mothers nursed most often early in the morning and later in the morning. Disturbing the breeding flock is to be avoided. No nursing was

observed on the 60th day, so the young chinchillas can be weaned before 56-60 days of age. By that time they have entirely switched over to consuming a solid diet and water.

Resting and cecotrophy as two behaviour elements are characteristic in the daytime: therefore, disturbing the chinchillas in this part of the day is undesirable.

Movement, eating and drinking were the most common elements at night. Timing of taking care, feeding, drinking and administering vitamins and/or drugs by the drinking water is recommended in the late afternoon hours.

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*Original Report*

## **The effect of litter size and individual weight at birth on the growth and mortality of chinchillas**

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### **Abstract**

By examining 77 chinchilla litters (144 newborn young) litter size expressed by the number of young ranged from 1 to 4 according to the following ratios: 26.8, 46.5, 23.9, 2.8 % respectively. The average litter size was 1.87.

In the different litters the average birthweights were as follows: 48.1, 47.0, 39.8, 37.6 grams, respectively. At the age of two and seven months (weaning and type classification age) the individual weight of the young born in litters of 2 was the highest (273 and 532 gr., respectively).

The average birthweight of the chinchillas was 43.6 gr.. Based on birthweight the chinchillas were divided into three groups: a/ under 41 gr., b/ 41-50 gr., c/ over 50 gr.. At the age of two months only group a/ was significantly smaller, and at the age of seven months there was no more any difference that could be verified statistically: the young born with low birthweight had compensated their backwardness.

The first week of life was crucial from the point of view of survival. During the first week mortality was lowest in the litters of 2 (9.1 %) and highest in the litters of 4 (25 %). At the age of seven months the death losses depending on litter sizes from 1 to 4 were as follows: 21.1, 18.2, 35.3, 50.0 %, respectively. Thus, only two young could be reared on average in the litters of 3 and 4. Mortalities in group a/, b/ and c/ depending on birthweight during the period from birth to weaning were 34.0, 14.7 and 10.7 %, respectively.

### **Introduction**

In the recent past the number of carnivores within the fur animal stock of Hungary has decreased, and this has resulted in the chinchillas' becoming the most important fur animal species in this country. At present, the chinchilla stock can be put at 5-6000 animals, approximately, and the chinchillas are mostly kept on small farms with 20-30 breeding females on each. In spite of all this, knowledge relating to chinchilla reproduction is insufficient in Hungary.

Through litter size and individual birthweight, maternal effect plays an important role in the growth and survival of the young of multiparous species. Observations made on rabbits as model animals, similar to the chinchillas in many respects, have emphasized that there is a negative phenotypic correlation ( $r= 0.33-0.46$ ) between litter size and individual birthweight (Krogmeier *et al.*, 1992, Lampo and van den Broeck, 1975, Moura *et al.*, 1991, Polastre *et al.*, 1992). The correlation existing between litter size and the amount of milk produced by suckling rabbits is also negative:  $r= -0.35$  (Lebas, 1975). According to observations made on chinchillas the number of young born alive per litter is in positive correlation with litter size at weaning ( $r= 0.73$ ) on one hand, and with litter weight at birth and at weaning ( $r= 0.94$  and  $r= 0.66$ , respectively) on the other hand. Day-old birthweight is related to the weights measured at weaning and at four and seven months of age as shown by the following correlation values:  $r= 0.21, 0.25$  and  $0.27$ , respectively (Neira *et al.*, 1988). Mothers accommodated in well-illuminated cages gave birth to remarkably larger litters in terms of both size and weight of the litters, as compared to mothers kept in dark cages (Garcia *et al.*, 1989). Previous studies have suggested that parity has an influence on litter size (Hillemann and Tibbitts, 1957).

Litter size and body weight at birth affect the survival of suckling chinchillas as well. In this investigation the author had the objective of evaluating the combined and single effects of litter size and birthweight as two important factors from the point of view of the maternal effect.

### Material and methods

The examinations were carried out on the standard chinchilla stock maintained at the Experimental Station of the Faculty of Animal Husbandry of the Pannon University of Agricultural Sciences. The breeding chinchillas were housed in a closed room, which was fitted with windows and heated in winter. The basic area of the room was 35 m<sup>2</sup>, the relative air humidity varied between 50-60 %, the temperature was 17-18 °C on average but became more elevated (20-25 °C) during the summer months.

The growing chinchillas were accommodated in a four-floor cage system, either on slatted floor or on bedding. The basic area of the cages was 40 x 65 cm, and their height was 35 cm. The traditional polygamic method of mating was applied, i. e. the males had access to the female breeders throughout the year, the only exception being the suckling period. The progeny were weaned at the age of 56-60 days and their type was classified when they were 200-210 days (7 months) old. The breeding and growing animals were fed a chinchilla mix available from commercial feed distributors. This mix was provided ad libitum until the age of seven months. Drinking water was available without limitation from chinchilla self-drinkers fitted with rubber teats.

Data on litter size at birth, individual body weight at birth, weaning and type classification and mortality during the first week, at two and seven months were processed. Three groups were formed according to birthweight as follows: a/ under 41 gr., the low quartile; b/ 41-50 gr., the interquartile; c/ over 50 gr., the upper quartile. Altogether, the data of 77 chinchilla litters (144 and 150 newborn chinchillas) were evaluated. The differences between the single groups were examined by analysis of variance in the course of the calculations concerning body weight, and by  $\chi^2$  - test in the case of mortalities (Précsényi *et al.*, 1995).

### Results and discussion

#### *Development of body weight*

The distribution of litter sizes showed the following frequencies:

Litter size	1	2	3	4
No. of progeny, %	26.8	46.5	23.9	2.8

The average litter size was 1.87. Other sources report litter sizes of 2.03 in Denmark (Anon., 1989) and 1.75 in Chile (Neira *et al.*, 1989)

Table 1 tells about the development of body weights at birth, weaning and seven months of age, depending on litter size at birth. At birth, the newborn from litters of 1 and 2 young chinchillas on one hand, and from litters of 3 and 4 young on the other hand proved to be similar in weight, the difference

between these two combined groups was, however, found significant ( $p < 0.001$ ). At the age of two and seven months the litters of 2 differed greatly from the others ( $p < 0.001$ ), while the largest body weight was measured in the litters of 2, too, at the age of seven months. This finding is surprising despite the fact that difference from the litters of 1 was not significant.

The chinchillas' birthweight ranged between 27 and 62 gr.; the average weight was 43.6 gr.. When two months old, the group of chinchillas born with small body weights still differed significantly from the groups in which the animals had been born with

intermediate or large weights ( $p < 0.05$ ). However, the significant differences among the three groups disappeared by the age of seven months (Table 2), which can probably be explained by the ability of the smallest newborn chinchillas to compensate partly for their initial backwardness.

The effect of litter size and body weight on the distribution of chinchilla litters is demonstrated in figure 1. This figure depicts the tendency that the ratio of the progeny born with small weight increases as litter size increases. This phenomenon is unfavourable for the chinchillas' later growth rate and for their chance to survive.

**Table 1** Effect of litter size at birth on the weight of chinchillas

Litter size	Individual weight								
	at birth			at 2 months			at 7 months of age		
	n (db)	x (g)	P (***)	n (db)	x (g)	P (***)	n (db)	x (g)	P (*)
1	18	48.1	A	14	248	AB	10	518	AB
2	66	47.0	A	59	273	A	47	532	A
3	51	39.8	B	37	230	B	20	506	AB
4	8	37.6	B	7	218	B	4	438	B

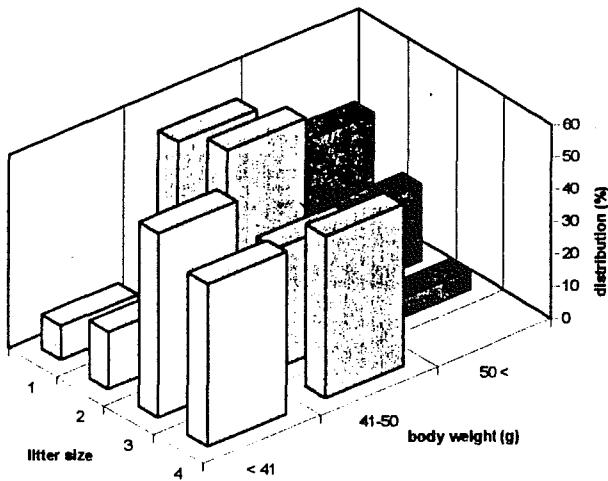
\*  $p < 0.05$ , \*\*\*  $p < 0.001$

**Table 2** Effect of birthweight of chinchillas on their weight at 2 and 7 months of age

Group	Individual weight								
	at birth			at 2 months			at 7 months of age		
	n (db)	x (g)	P (*)	n (db)	x (g)	P (*)	n (db)	x (g)	P (NS)
1. < 41 g	47	35.6	A	31	218.6	A	19	499.3	A
2. 41-50 g	75	45.8	B	64	260.0	B	47	517.5	A
3. 50 g <	28	54.5	C	25	274.0	B	14	538.1	A
1-3	150	43.6		120	252.0		80	517.0	

\*  $p < 0.05$ , NS  $p > 0.05$





**Fig. 1.** Distribution of chinchilla litters according to body weight and litter size at birth.

The examination detected a significant relationship between body weight at birth and at two months of age ( $r=0.48$ ,  $p<0.0001$ ) on one hand, and between body weights at two and seven months of age ( $r=0.46$ ,  $p<0.0001$ ) on the other. In contrast to the results by *Neira et al. (1989)*, there was actually no relationship between birthweight and body weight at seven months of age ( $r=0.14$ ,  $p>0.1$ ). It is worth noting, however that these correlation coefficients

have no adequate reliability due to the small number of samples taken into account.

### Development of mortality

The numbers in Table 3 demonstrate the development of animal losses as a function of litter size at birth. The first week proved to be crucial from the point of view of the chinchillas' survival since more than half of the losses occurred during this short period. It can be observed that the fewest animals were lost in the litters of 2 (9.1%). This group was followed by the litters of 1, 3 and 4. Looking at the losses between the first two weeks of life and weaning time at two months of age it can be stated that there were no losses in the litters of 1 and 2, while the losses were as low as 1.9% in the litters of 3 and as high as 12.5% in those of 4. The effect of litter size is detectable in terms of the death losses after weaning, too. As compared to the litters of 1 newborn (5.3%) the losses were more than twice as big in the litters of 3 (11.8%) and 4 (12.5%). To sum up, it can be stated that - in litters of 3 - two growing animals survived until type classification time. Mortality rate was even more unfavourable in litters of 4 since in these only every other young survived up to seven months of age.

**Table 3** Effect of litter size at birth on the mortality of chinchillas

Litter size at birth	Number of youngs	Mortality (%)		
		during 1st week	between 1 week and 2 months of age	between 2 and 7 months of age
1	19	15.8	-	5.3
2	66	9.1	-	9.1
3	51	21.6	1.9	11.8
4	8	25.0	12.5	12.5
1-4	144	15.3	1.4	9.7

Similarly to the observations described in relation to the development of birthweight, it is true for the death losses, too, that small litter size (one newborn) is, although slightly, less favourable than a litter size of 2, which can be considered optimum in

many respects. Similar tendencies have been observed in rabbits (*Szendrô, 1995*) and mink (*Korhonen, 1992*), too. Presumably, these mothers produce litters with only one newborn because they are not able to carry the embryos to term successfully due

to their own poor body condition or health. This may result in high embryonic mortalities, and consequently, in small litter sizes, but postpartum losses until weaning are also higher. Death losses as a function of birthweight are shown in Table 4, and also - in more details -, in figure 2.

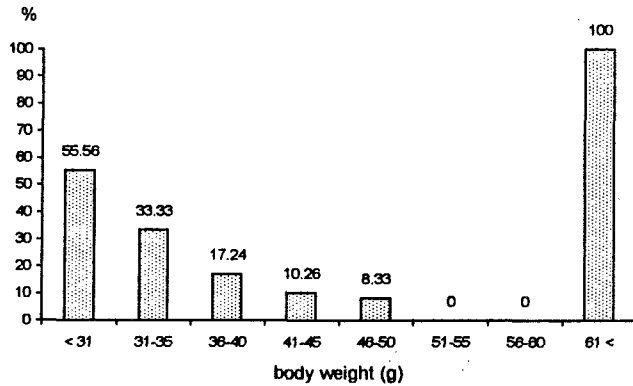


Fig. 2. Effect of body weight at birth on the mortality of chinchillas (from birth to weaning).

The results point at the opposite tendencies existing in body weight and mortality rate from birth to weaning: as body weight increases, mortality decreases. An exception are the chinchillas born with a weight over 60 gr. In their case the rate of mortality is 100 %. The reason for that lies in the phenomenon that these newborn are very agile and lively from the early hours after birth, and they get to the place of another mother through the buck's corridor before the corridor has been blocked, and that female kills them. By modifying the technology of keeping (buck corridor inside the mothers' cages), and by proper organization of animal care (Anon., 1988) (the time of blocking the buck's corridor should be determined based on the weight of the newborn) the occurrence of such cases can be reduced.

Of course, it should not be neglected either that the small chinchillas were born in large litters almost exclusively, so their high mortality rate can be attributed to the poor rearing issues apart from their low viability.

The death losses until weaning of suckling chinchillas as a function of litter size and birthweight are shown in figure 3. The data indicate that the young born with a small weight die at a high rate (25.0-

33.3 %), which emphasizes the opposite tendency as compared to litter size. The relatively high rate of mortality among young chinchillas of over 41 gr. of birthweight as observed in some litters goes back to the reasons mentioned above. Otherwise, these young stand the best chance of staying alive in the other litters.

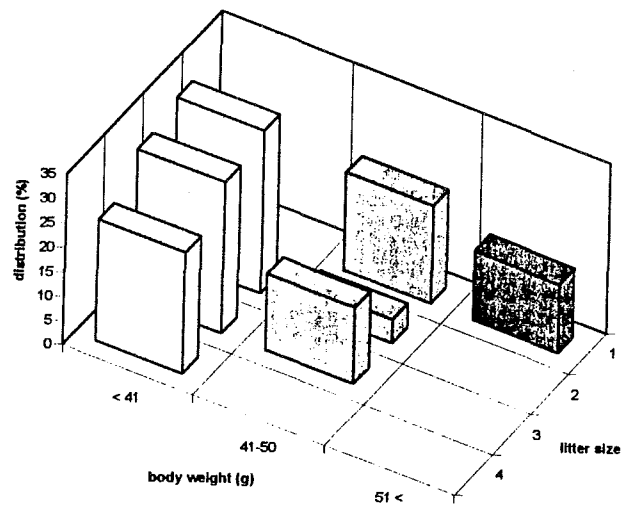


Fig. 3. Effect of body weight and litter size at birth on the mortality of chinchillas until 2 months of age.

For better rearing results the most viable young originating from large litters are recommended to be put out to nurse. However, this opportunity is rarely feasible on the small domestic farms because of the scattered litterings on these.

Table 4 Effect of weight at birth on mortality until weaning

Group	Number of youngs	Mortality from birth to weaning (%)	P (*)
1. < 41 g	47	34.0	A
2. 41-50 g	75	14.7	B
3. 50 g <	28	10.7	B
1-3	150	20.0	

\* P < 0.05

## Conclusions

1. Litter size and individual body weight at birth provide preliminary information on the expectable growth of young chinchillas. The chinchillas born with large body in smaller litters will be bigger at weaning, and also, at the time of type classification.
2. The first week of life proved crucial from the point of view of rearing young chinchillas.
3. By modifying the technology of keeping and animal care the rate of death losses can be reduced.
4. The rearing results are most favourable in the cases of litters of 2, the cases that occur most frequently, and the body weight of the growing animals is largest in these litters both at weaning and at type classification time. As litter size increases, the individual body weight measured at two and seven months of age decreases and the efficiency of rearing becomes reduced. Actually, only two newborn can be reared successfully in litters of 3 and 4. For this reason -especially in small populations-, litter size is not worth increasing through the practical breeding of chinchillas.

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*Original Report*

## The changes of some blood indices of fur animals in the lactation period

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### Summary

The morphological and biochemical indices of mink and fox female blood in the lactation period at different feed conditions were studied from 1990-1994. The influence of deficient feeding and feed composition on the serum protein fractions and on the activity of blood enzymes were established. It was shown, using correlation analysis, that the typical manifestation of exchange violation in fur animals was increasing connection between blood indices at unbalanced rations.

### Introduction

The lactation period is characterized by an increased basal metabolism. The energy balance requires increased nutrients to the milk glands (Gratsev, Galantsev, 1973).

Environmental factors and management influence the efficiency of lactation (Jorgensen, 1985). Deficient feed intake or deficiencies in the composition of the feed can be a reason for nursing disease (lactation emaciation) - an illness in the lactating female. This disease is mostly observed in mink. As pre-

vious studies have shown, the females have deficient protein turnover with hypoalbuminaemia and changes in serum enzyme activity (Berestov, Kozhevnikova, 1981; Brandt, 1989). The kits of sick females often have slow growth and reduced resistance to infection.

Studying the turnover in lactating animals is important for understanding the adaptation processes in the maternal organism to nursing and for designing methods of protection and treatment of nursing disease. Effective preventive measures must be based on early diagnostics using morphological and biochemical blood indices. Data on changes in blood indices in lactating fur animals are not numerous (Brzozowski *et al.*, 1994; Stanislawski, 1979, 1981; Stanislawski *et al.*, 1979). Neither are investigations regarding nursing disease (Berestov, Kozhevnikova, 1981; Brandt, 1989).

### Materials and methods

The laboratory of ecological physiology monitored farmed fur animal populations in Karelia for phy-

siological status using the following morphological and biochemical parameters: Erythrocytes (RC), hemoglobin (Hb), total serum protein (PROT), albumins (Alb), alpha-globulins (A-gll), beta-globulins (B-gl), gamma-globulins (G-gl), aspartate aminotransferase (ASAT), alanine aminotransferase (ALAT), lactate dehydrogenase (LDH), alkaline phosphatase (AP), superoxide dismutase (SOD). The methods of measuring these indices have been described previously (*Berestov, 1981; Ilukha, 1991*).

In this article we use only results obtained in 1990-1994 on the fur farms "Kondopogskiy zverovod" and "Veskelskoe". The breeding results (litter size, date of birth) and ages were also registered. The general characteristics of the animal groups and conditions of the experiment are shown in Table 1.

All obtained results were computed statistically. The significance of differences was tested using Chi-square test.

## Result and discussion

The data show a relation between mink and fox blood morphological and biochemical indices during lactation and feed composition. In mink fed a balanced diet until the end of lactation the initial of albumin level remained the same high level but the concentration of globulins was increased. In the blood of all examined females, except the young, was observed a lower content of alpha-globulins (Table 2). All females before weaning had a lower erythrocytes count. Females with larger litters had decreasing levels of haemoglobin.

The changes in the enzyme spectrum consisted of increasing LDH activity in young mink females incl. females with both small and large litters. This was accompanied by lowered AP and ALAT activity. No injury to the structure of the liver was observed but its protein synthesising function was changed. The increasing LDH activity can be connected with glycolysis.

**Table 1.** The general characteristics of the animal groups and their experimental conditions

Experimental groups	Species	Number of animals	Conditions of life and experimental conditions
1	Fox Mink	5 24	Start of lactation period. Normal feeding.
2	Fox Mink	5 25	End of lactation period. Normal feeding.
3	Fox Mink	4 18	Middle of lactation period. Deficiencies in the protein composition of the feed.
4	Fox Mink	6 22	Middle of lactation period. 10% deficiency of protein in the feed and more than 10% deficiency in total energy.

**Table 2.** Morphological and biochemical indices (means±SD) of mink blood in the lactation period under normal feed conditions

Parameters	Exp. group 1				Exp. group 2			
	A	B	C	D	A	B	C	D
n	18	6	16	8	4	21	21	4
RC	8.05	7.92	8.00	8.06	7.11*	7.24*	7.16*	7.54*
	0.14	0.12	0.15	0.11	0.19	0.12	0.10	0.34
Hb	17.73	17.38	17.75	17.45	18.00	17.24♦	17.40	17.15
	0.26	0.43	0.27	0.40	0.29	0.22	0.18	0.88
PROT	7.81	7.84	7.83	7.79	8.56*	8.10	8.15	8.30
	0.11	0.24	0.13	0.16	0.14	0.11	0.11	0.25
Alb	52.20	50.18	52.55	50.00	54.56	52.48	52.65	53.64
	0.76	1.95	0.81	1.46	2.18	1.24	1.24	2.34
A-gl	19.03	19.60	18.53	20.45	17.30	14.56*	15.34*	13.16*
	0.82	0.69	0.55	1.51	0.85	0.69	0.66	1.70
B-gl	14.13	14.46	13.74	15.15	11.45	14.86	14.44	13.70
	0.74	0.96	0.49	1.52	1.04	0.89	0.88	2.06
G-gl	14.44	15.57	14.98	14.21	16.67*	18.08*	17.55*	19.47*
	0.72	1.68	0.83	1.21	2.14	0.97	0.98	1.84
ASAT	55.72	57.16	53.00	62.25	56.25	62.28	60.95	63.25
	2.74	9.34	3.53	5.14	5.94	1.92	2.13	3.66
ALAT	42.16	44.50	42.37	43.50	35.25*	32.84*	32.54*	36.75*
	2.33	4.91	2.77	3.16	4.50	2.20	2.31	0.85
LDH	7.54	6.77	7.22	7.60	9.20*	8.94*	9.27*	7.47♦
	0.49	0.85	0.62	0.32	1.28	0.52	0.53	0.68
AP	22.68	17.59	21.74	20.76	16.89*	16.33	15.70*	19.72
	3.13	2.57	3.55	2.20	3.01	1.34	0.95	5.54
SOD	60.12	64.75	64.16	55.50	74.00	52.34♦	58.04	45.50
	3.34	7.33	3.87	4.50	6.04	3.40	3.59	8.89

A - females with small litter sizes (1-5 kits), B - females with large litter sizes (more than 6 kits),  
C - young females, D - old females.

Differences were significant (\* - compared with Exp. gr. 1, ♦ - between groups A and B, C and D; Chi-square test).

Using feed rations deficient in protein and energy for lactating mink resulted in changes in the composition of serum proteins and enzyme activity. In comparison with the norm redistribution of the serum protein fractions consisted of a lowering of the albumin concentration and an increase in alpha-globulins (Table 3, fig. 1). As previous studies have shown, the hypoalbuminaemia is the most frequent feature of females with nursing disease (*Berestov, Kozhevnikova, 1981; Brandt, 1989*). The changes in the fox blood during lactation compared with mink were analogous. The character of the turnover pro-

cess was dependent on adequate provision of the necessary nutrients and energy (Table 4, fig. 1).

The changes in serum protein composition and enzyme activity which regulate protein turnover in female foxes were more intensive than in mink. In both mink and foxes were observed many common change in most of the investigated blood indices. At deficient feeding the most typical feature in the serum protein picture in the lactation period was hypoalbuminaemia and increasing ALAT activity. It is probably that the most drastic changes was tread

when normal ASAT/ALAT ratio was disturbed (decreasing Ritis coefficient).

As a result of deficient intake or deficiencies in the composition of the feed the lactating mink and foxes had considerably decreased functional synthesis. This was mostly manifest in decreasing the serum albumin content and the hemoglobin concentration. The most typical for the enzyme spectrum was a lowering of the ALAT activity and a change in the normal ASAT/ALAT ratio.

By correlation analysis it was shown that deficient feeding increases the correlation between blood indices, particularly in foxes (fig. 2). Correlation analysis can be used for the control conditions of the lactating females, particularly in case of the development of nursing disease.

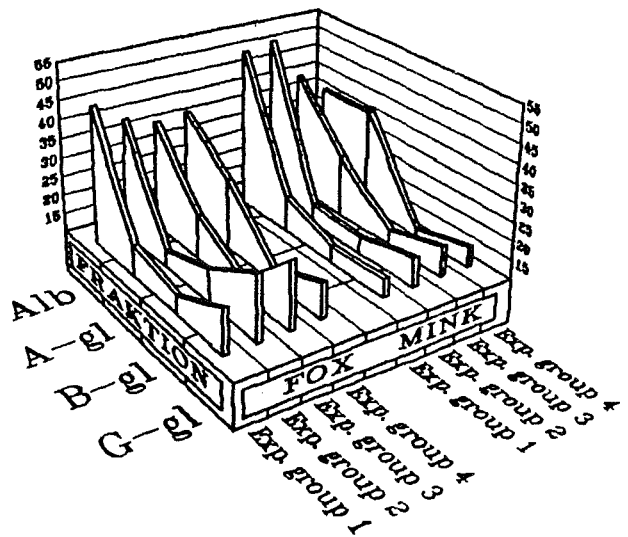


Fig. 1. The effect of different feed conditions during the lactation period on the fox and mink serum protein fraction.

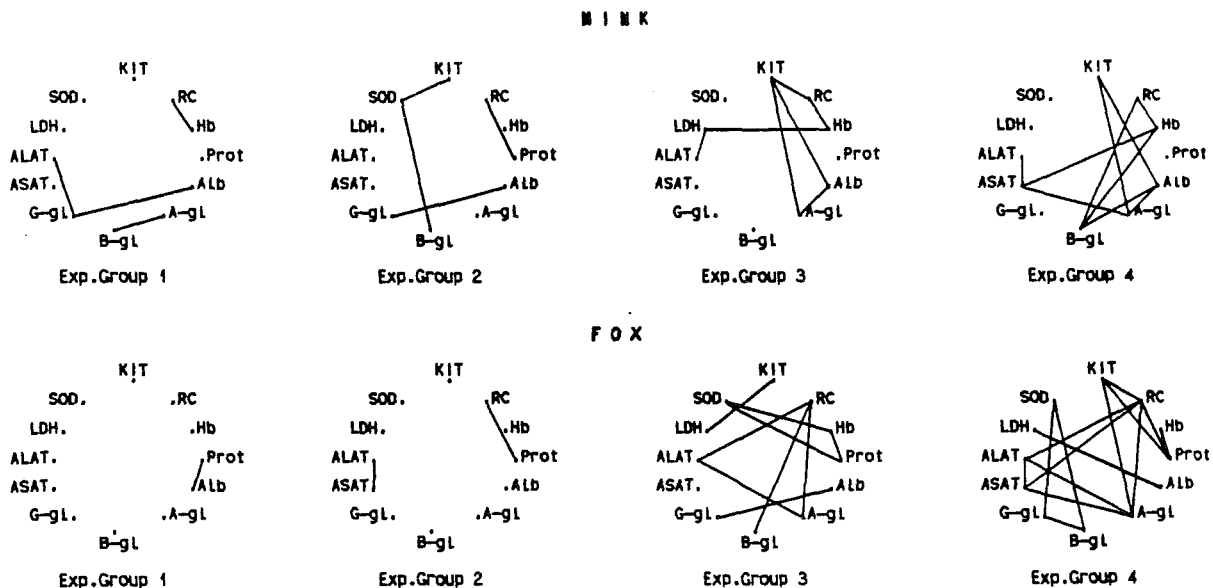
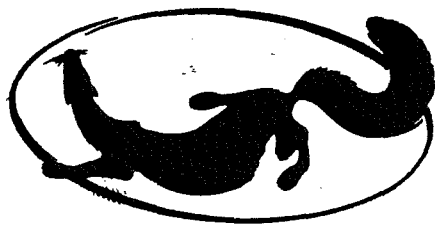


Fig. 2. Correlation dependence between some blood indices during the lactation period at different feed conditions. Only significant ( $P < 0.05$ ) dependence was marked.

**Table 3.** Morphological and biochemical indices (means±SD) of mink blood during the lactation period under the abnormal feed conditions

Parameter	Exp. group 3		Exp. group 4	
	A	B	A	B
n	12	6	16	6
RC	8.13 0.28	8.62 0.15	7.66* 0.11	7.05◆■ 0.26
Hb	18.03 0.63	18.66 0.51	17.50* 0.28	15.89◆■ 0.79
PROT	8.20 0.11	8.09 0.23	7.78 0.11	7.96 0.27
Alb	42.74* 2.61	39.35*◆ 1.55	39.77*■ 2.53	26.23*◆■ 3.52
A-gl	24.93* 1.97	28.87*◆ 1.74	32.38*■ 1.60	47.43*◆■ 3.80
B-gl	13.78 1.03	14.21 0.95	11.73 1.12	12.11 1.13
G-gl	18.54* 1.42	17.56* 1.60	16.10■ 1.36	14.21◆ 2.54
ASAT	65.75* 3.66	63.79* 6.67	41.62*■ 4.06	47.50*◆■ 4.29
ALAT	47.50 2.36	43.33 2.38	73.56*■ 4.40	83.50*◆■ 7.57
LDH	10.14* 1.08	10.26* 1.12	5.57*■ 0.38	6.12*■ 0.60
SOD	153.20* 7.20	139.70* 7.14	89.80*■ 2.75	87.19*■ 5.25

A - females with small litter sizes (1-5 kits)

B - females with large litter sizes (more than 6 kits)

Differences were significant (\* - compared with Exp. gr. 1, ◆ - between groups A and B,

■ - Exp. gr. 3; Chi-square test)





**Table 4.** Morphological and biochemical indices (means±SD) of fox blood during the lactation period under different feed conditions

Parameters	Exp. gr. 1	Exp. gr. 2	Exp. gr. 3	Exp. gr. 4
n	5	5	4	6
RC	8.02	7.22 <sup>A</sup>	8.29	7.15 <sup>A</sup>
Hb	17.65	17.36	18.25	16.27
PROT	7.82	8.17 <sup>A</sup>	8.16 <sup>A</sup>	7.83
Alb	51.70	52.82	41.62 <sup>AB</sup>	36.08 <sup>AB</sup>
A-gl	19.18	15.00	26.24 <sup>AB</sup>	36.49 <sup>ABC</sup>
B-gl	14.22	14.32	13.93	11.84 <sup>A</sup>
G-gl	14.73	17.86 <sup>A</sup>	18.21 <sup>A</sup>	15.59
ASAT	56.08	61.32	61.56	43.23 <sup>ABC</sup>
ALAT	42.75	31.92 <sup>A</sup>	46.11 <sup>B</sup>	76.27 <sup>ABC</sup>
LDH	7.35	8.98 <sup>A</sup>	10.19 <sup>AB</sup>	5.72 <sup>ABC</sup>
SOD	61.28	53.72	115.44 <sup>AB</sup>	80.93 <sup>AB</sup>
	3.05	4.00	15.69	6.04

Differences were significant (A - compared with Exp. gr. 1, B - with Exp. gr. 2, C - Exp. gr. 3; Chi-square test).

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*Original Report*

## Seasonal variation in the isoenzymatic profile of lactate dehydrogenase in the organs of farm mink and polar foxes

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### **Abstract**

The separation of isoenzymes of lactate dehydrogenase (EC 1.1.1.27) in extracts of liver, heart and skeletal muscles of mink and polar foxes by agar gel electrophoresis reveals seasonal variations in the ratio of electrophoretic fractions of the enzyme. It has been shown that in winter the rearrangements of the isoenzymatic spectrum of LDH is manifested in the increased relative content of the B-subunits of the enzyme in the total lactate dehydrogenase activity, decreased anaerobiosis coefficient in the tissues of liver and skeletal muscles. The aerobic pathways of glycolysis were concluded to be important in the adaptation to cold by fur animals.

### **Introduction**

In the process of the evolution of fur-bearing animals of the predator order physiological and biochemical adaptations to changing environmental conditions have appeared. In the annual periodicity of biological functions the rhythm of metabolism

acquires special importance, since it has the principal role in the organism's adaptational response (*Hochacka, Somero, 1977*). The annual cyclicality of the basal metabolism is reflected in seasonal rearrangements in heat production and oxygen consumption in fur-bearing animals (*Segal, 1975; Danilow, Tumanov, 1976; Harri, Korhonen, 1982*).

Seasonal adaptations are inherent in the total activity of a number of serum enzymes in mink and polar foxes (*Berestov, Kozhenikova, 1980; Kozhevnikova, 1987*) reflecting the fluctuations in the protein, fat and hydrocarbon exchanges throughout the year. Not only the total activity of the glycolytic enzyme in blood serum LDH but also the relative content of its molecular forms have seasonal cyclicality (*Kozhevnikova et al., 1988*). Taking into account the organ origin of the isoenzymes of blood serum LDH, it seemed interesting to reveal the role of different organs in their formation at the change of the seasons and determine the direction of glycolysis in the adaptation to changing environmental factors.

## Materials and methods

Studies have been made on farm-bred adult mink and polar foxes. Extracts of liver, heart and skeletal muscle tissues obtained from fur animals in February, April, July, and November (Meldo, Unzhakov, Ostashkova, 1987) were used to investigate the isoenzymatic LDH profile (LDH, EC, 1.1.1.27).

Multiple molecular lactate dehydrogenases forms in organs were revealed by agar electrophoresis (Wieme, 1959) modified by E.G. Gorozhanskaya and V.S. Shapot (1973) on a home device "PEF-3". The electrophoresis was performed in the veronal-medinal buffer, pH = 8.6, ionic strength 0.05, tension 3-4 V/cm and strength of the current 50 ma/cm for two hours. The qualitative ratio of LDH isoenzymes was estimated by scanning electrophoregrams (after their histochemical staining) on a microdensitometer "Chromoscan-200".

## Results and discussion

In the studied representatives of the predator order - mink and polar foxes - the general regularities in the distribution of isoenzymatic LDH fractions in a number of organs and distinct differences depending on ecological specialization of a species were observed (Kozhevnikova, 1989).

The general regularities consisted in the tissue (organ) specificity of the sets of LDH isoenzymes corresponding to their metabolism level.

For instance, in the tissues with predominantly aerobic exchange, such as the heart, the leading part in mink as well as in polar foxes was played by LDH isoenzymes with B-type subunits prevailing (fig. 1, Table 1). In this case the summary content of anodic forms (LDH-1 + LDH-2) made up in mink 70%, in polar foxes - 90% of the total activity. The portion of cathodic enzyme forms (LDH-4, LDH-5) was low and fluctuated in mink between 1.6 (LDH-4) and 4.5 (LDH-5), in polar foxes correspondingly between 2.5 and 2.9%. A high content of the LDB B-subunits in the heart extracts was observed throughout the year, which provided a sustained aerobic glycolysis independently of seasonal and temperature changes. During the year the isoenzymatic spectrum of LDH in heart tissue on the whole corresponded to the organ specificity in the distribution of the fractions. Within the limits of this distribution a decrease in the relative content of LDH-1 and a simultaneous 1.6-fold increase in the content of a hybrid isoenzyme LDH-4 ( $P < 0.05$ ) occurred in mink in spring compared with winter. The content of the latter in polar foxes increased only in autumn and exceeded the summer level nearly 3-fold ( $P < 0.01$ ).

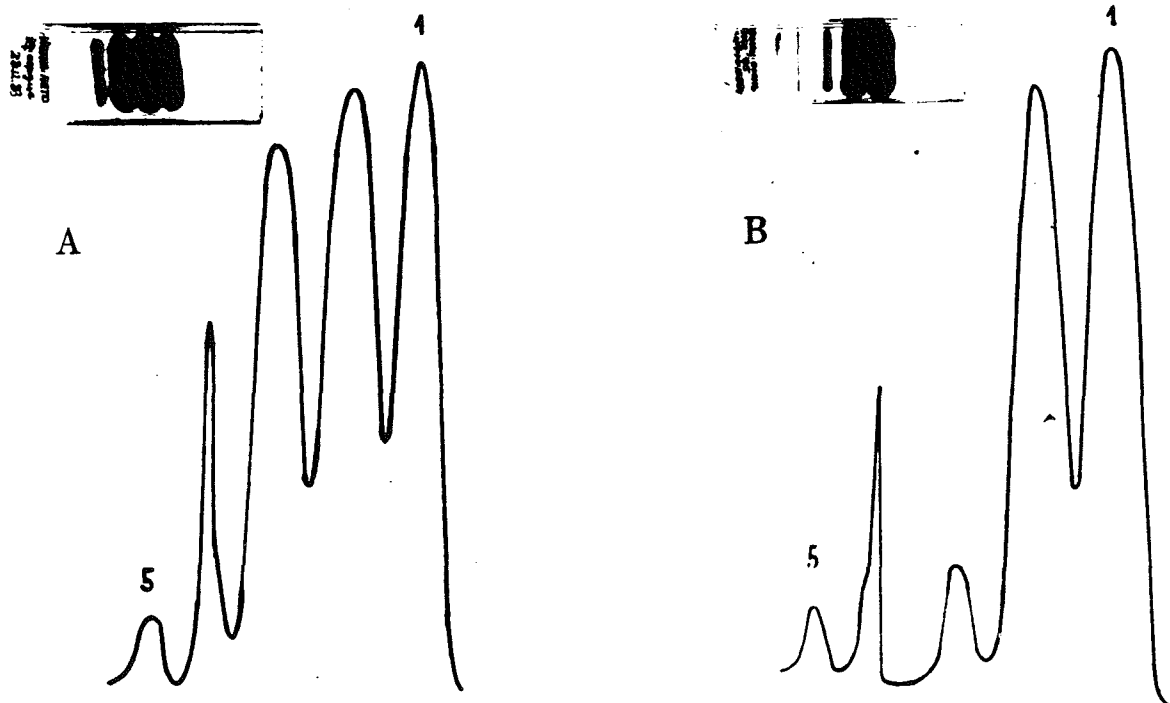


Fig. 1. Enzymograms of LDH in hearts of mink (A) and polar fox (B)

**Table 1.** Distribution of LDH isoenzymes in heart tissues of mature fur animals in different seasons

Seasons	Statistical indices	LDH fractions, % of total activity				
		1	2	3	4	5
Mink						
Winter	M	34.48	36.54	25.04	2.89	1.05
	m	0.72	0.28	0.52	0.21	0.12
Spring	M	30.45*	35.98	27.10	4.69	1.78
	m	1.43	1.09	0.89	0.61	0.37
Summer	M	35.03	38.50	19.88	4.58	2.01
	m	1.70	0.67	2.00	0.48	1.03
Autumn	M	31.45	36.96	24.33	5.68	1.58
	m	1.34	1.51	1.03	1.14	0.55
Average annual	M	32.85	37.00	24.09	4.46	1.61
	m	0.72	0.48	0.59	0.33	0.21
Polar foxes						
Winter	M	52.90	36.47	4.30	2.27	4.06
	m	1.74	2.13	0.69	0.54	1.15
Spring	M	54.77	37.13	4.04	2.19	1.87
	m	0.76	0.88	0.30	0.22	0.37
Summer	M	57.11	34.92	3.97	1.85	2.23
	m	1.57	1.73	0.66	0.21	1.53
Autumn	M	52.18	35.66	4.56	5.47**	2.14
	m	3.74	1.72	1.91	0.99	0.79
Average annual	M	54.24	36.05	4.22	2.95	2.58
	m	1.13	0.72	0.53	0.41	0.44

Note: here and further = \* - significantly different from the previous seasons -  $P < 0.05$ ; \*\* -  $P < 0.01$ ; \*\*\* -  $P < 0.001$ .

In the tissues with predominantly anaerobic exchange, e.g., liver, along with all five LDH fractions, the isoenzymes incorporating A-type subunits prevailed (fig. 2, Table 2). In mink and polar fox liver extracts the portion of LDH-5 made up on average 70% of the total activity and the total content of the cathodic fractions (LDH-4 + LDH-5) - 83.2% in mink and 77.5% in polar foxes. In this case the relative content of LDH anodic fraction was not high, averaging in mink 2.11 (LDH-4) and 4.15% (LDH-5), and somewhat higher in polar foxes - 8.5 and 5.99%, respectively.

When such organ specificity in the distribution of LDH isoenzymes was related in the liver tissues, an almost 2-fold increase in the relative content of LDH-4 was observed in mink in spring compared to

winter ( $p < 0.05$ ). In polar foxes a 1.25-fold growth in LDH-5 activity ( $p < 0.01$ ) was recorded in summer compared to the previous season, which was attended by a nearly 2-fold fall in the relative content of the hybrid isoenzymes LDH-2 ( $p < 0.05$ ).

It is interesting to compare the total content of the anodic and cathodic LDH form by seasons and to calculate the anaerobiosis coefficient (ratio of the activity of LDH-5 to LDH-1).

**Table 2.** Isoenzymatic profiles of LDH in the liver of mink and polar foxes in different seasons

Seasons	Statistical indices	LDH fractions, % of total activity				
		1	2	3	4	5
Mink						
Winter	M	4.14	5.73	12.62	7.03	69.23
	m	0.71	0.92	1.41	0.92	2.37
Spring	M	1.97	4.51	9.01	13.47*	71.04
	m	0.61	0.94	1.74	1.63	1.91
Summer	M	0.91	3.53	11.63	15.93	68.00
	m	0.56	1.19	2.46	2.09	3.27
Autumn	M	1.43	2.82	11.57	14.93	73.35
	m	0.88	0.93	1.39	1.16	1.72
Average annual	M	2.11	4.15	11.21	12.84	70.39
	m	0.43	0.54	0.91	0.86	1.10
Polar foxes						
Winter	M	8.71	10.63	11.43	6.92	62.31
	m	2.00	1.32	1.26	0.76	3.02
Spring	M	12.37	7.93	8.71	7.87	61.97
	m	2.62	1.26	1.43	0.71	2.57
Summer	M	6.37	3.21*	3.94*	8.70	77.78*
	m	1.41	0.82	0.86	1.42	2.32
Autumn	M	6.85	2.20	6.31	14.73	69.91
	m	2.04	0.76	1.63	3.66	2.40
Average annual	M	8.58	5.99	7.60	9.56	68.00
	m	1.10	0.86	0.83	1.44	1.78



It appeared that in mink the total content of the fractions LDH-4 + LDH-5 decreased during winter from 88.25 (autumn) to 76.23% and the total LDH-1 + LDH-2 increased in February to twice that in autumn.

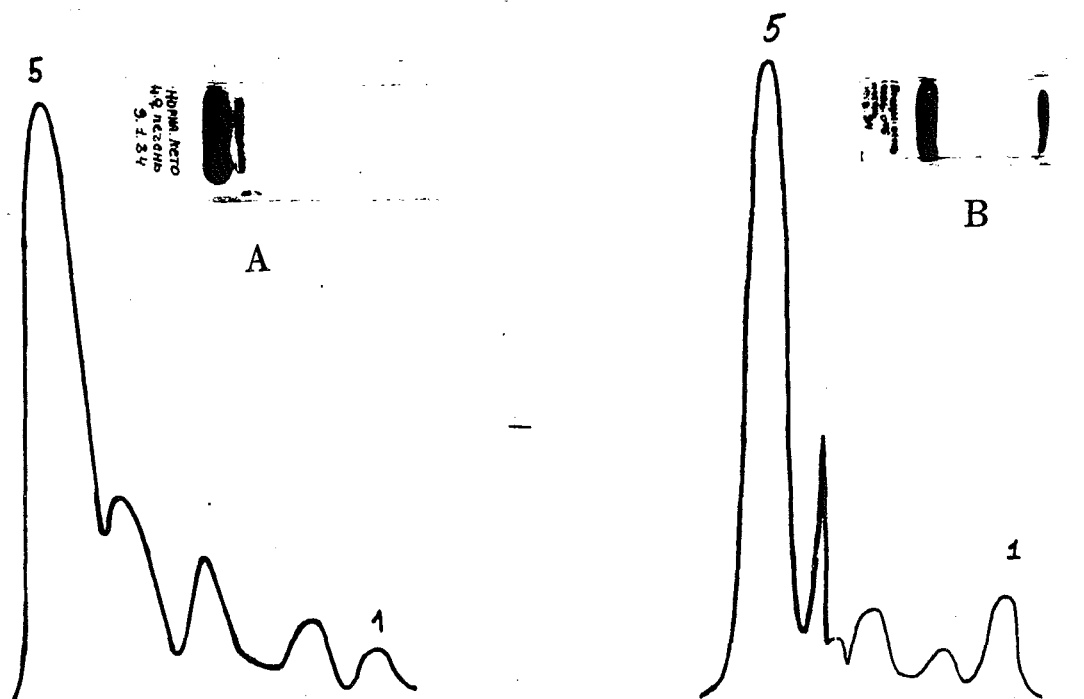


Fig. 2. Enzymograms of LDH of liver of mink (A) and polar foxes (B)

In summer the anaerobiosis coefficient made up in mink 74.7, whereas after the first autumn colds it decreased to 51.3 and during February frosts it reached 16.71. In polar foxes we observed a similar correlation of anodic and cathodic LDH fractions, but the response to a temperature decrease showed up only in February when not only the total content of the cathodic isoenzymes was reduced from 84.64 to 69.23% but the content of anodic grew from 9.56 (autumn) to 19.34%, i.e. twice that in autumn. We have recorded a delayed response to a decreased environmental temperature by polar foxes compared to mink earlier while studying the general activity of serum enzymes (*Berestov, Kozhevnikova, 1980*), which conforms with the information by A.O. Slo-nim (1986) about a less pronounced effect of environmental factors on the metabolism of polar foxes.

Five isoenzymes LDH were revealed in the extracts of skeletal muscles of mink and polar foxes (fig. 3, Table 3). In mink over half of the activity fell on LDH-5. Its relative content averaged 58%. The anodic forms LDH-1 (1.26%) and LDH-2 (6.54%) had the lowest activity. The content of the cathodic isoenzyme LDH-5 was also the highest in the skeletal muscle tissue of polar foxes - 45%, a quarter of the lactate dehydrogenase activity belonged to LDH-1. Along with a high LDH-5 content in both spe-

cies, the total content of the cathodic isoenzymes in mink exceeded that in polar foxes by one-third, while a relative LDH-1 content was higher in the latter than in mink. This led to the almost 20-fold difference in the values of the anaerobiosis coefficient (in mink - 46.1, in polar foxes - 1.87) which testified to a greater ability of skeletal muscles to the aerobic glycolysis.

Seasonal rearrangements in the isoenzymatic LDH spectrum of skeletal muscles were different in mink and polar foxes. In mink the summer period was characterized by the maximum activity of LDH-5 and the lowest content of LDH-4. In autumn a 1.3-fold fall in the relative content of LDH-5 ( $p < 0.01$ ) and a 1.5-fold growth of the hybrid isoenzyme LDH-3 ( $p < 0.05$ ) was observed compared with summer. In spring only the content of LDH-3 reliably decreased - 3-fold ( $p < 0.05$ ) - compared to winter.

In polar foxes the rearrangements in the LDH isoenzymatic spectrum of skeletal muscles embraced the spring and autumn periods excluding summer. In spring the content of LDH-2 increased nearly twice relative to winter ( $p < 0.01$ ) and in autumn a three-fold decrease of LDH-1 ( $p < 0.01$ ) was observed, which was attended by a 1.6-fold increase in the relative content of LDH-5 ( $p < 0.01$ ) in comparison with summer.

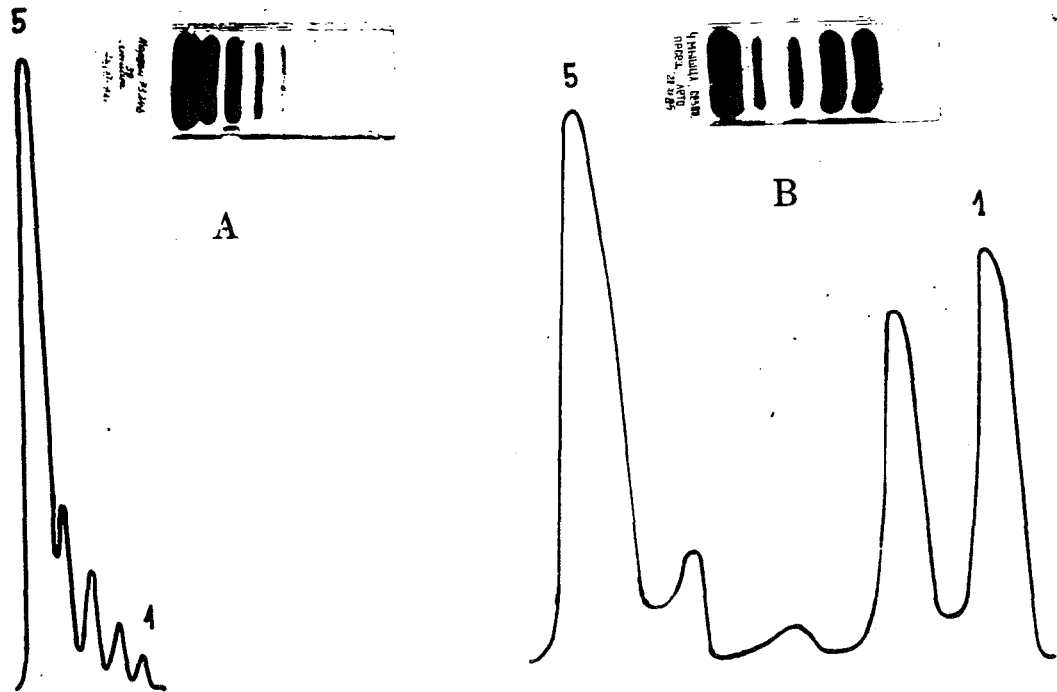


Fig. 3. Enzymograms of LDH of skeletal muscle of mink (A) and polar fox (B)

Table 3. Isoenzymatic profiles of LDH in the skeletal muscles of mink and polar foxes in different seasons

Seasons	Statistical indices	LDH fractions, % of total activity				
		1	2	3	4	5
Mink						
Winter	M	4.81	5.35	16.58	16.04	57.22
	m	0.28	1.90	2.76	2.52	7.10
Spring	M	1.36*	6.32	16.85	18.94	56.53
	m	0.31	1.14	1.63	1.33	3.01
Summer	M	1.93	4.95	12.26	13.84*	67.03**
	m	0.44	1.05	1.66	1.63	2.05
Autumn	M	1.38	7.83	19.34*	21.77	48.36**
	m	0.53	2.05	2.60	1.57	4.65
Average annual	M	2.37	6.11	16.32	17.65	57.69
	m	0.21	0.76	1.10	0.96	2.43
Polar foxes						
Winter	M	24.54	12.31	5.87	11.44	45.86
	m	1.87	2.22	1.22	2.06	3.43
Spring	M	29.20	23.96***	7.73	6.22	38.94
	m	2.99	1.94	1.32	1.23	2.56
Summer	M	32.37	18.98	5.09	7.09	36.60
	m	2.34	3.23	2.05	1.19	5.71
Autumn	M	9.77***	14.22	6.03	11.19	58.80**
	m	1.57	1.93	1.11	2.21	2.08
Average annual	M	23.97	17.36	6.18	8.98	45.05
	m	2.16	1.46	0.69	0.98	2.25

When the autumn-winter LDH spectra of the skeletal muscles of mink and polar foxes are compared, a general trend towards an increase of the relative content of LDH-1 is observed in February compared to November. In mink the isoenzymes of group B (LDH-1) determined the lowest anaerobiosis coefficient in winter (11.89), whereas its value in polar foxes also depended on a decrease in relative content of the cathodic isoenzyme LDH-5 compared with autumn. As in the case with the isoenzymes of the liver tissues, the skeletal muscle tissue of mink responded to the seasonal fall of the environmental temperature by a decrease in the relative content of LDH-5 a season earlier than of polar foxes, i.e. in autumn.

The seasonal rearrangements in the relations between the isoenzymatic LDH spectra of the studied organs covered not only the "pure" isoenzymes (LDH-1 and LDH-5) but also the hybrid ones; it referred to LDH-4 to the greatest extent, its relative content changed in spring and LDH-2 and LDH-3 in summer.

The environmental pressure attended by a change in the relative content of the isoenzymes with polypeptide A or B, is evidently connected with the physiological requirements of the organism. Though biochemical reactions catalyzed by enzymes and their molecular forms occur inside the cells of different



organs, the blood washing them reflects the direction of metabolism on the whole (Berestov, Kozhevnikova, 1981). Undoubtedly, the changes in the molecular profile of the lactate dehydrogenase of organs play a significant role in seasonal rearrangements of the isoenzymatic LDH spectrum in the blood serum of mink and polar foxes. It should be noted that the general direction in the changes of the isoenzymatic LDH spectrum of blood serum by seasons (Kozhevnikova et al., 1988) was analogous to those in liver and skeletal muscles and evident of fine regulation in the biochemical functions of an organism in conformity with changing environmental conditions showing a direct participation of the systems responsible for energy provision in the adaptational processes. In homogenates of liver and skeletal muscles as well as in blood serum the lowest anaerobiosis coefficient was in winter. Its value was always lower in polar foxes than mink which was conditioned by a higher, than in the latter, content of LDH-1.

It is known that LDH isoenzymes having a common substrate specificity are not identical (Lehninger, 1976; Wilkinson, 1981) and the physiological sense of their existence with polypeptides A and B consists in fine regulation of the alternative ways of metabolism: LDH-5 (A) catalyzing the final stages of the anaerobic transformation of carbohydrates (reduction of pyruvate to lactate) whereas LDH-1 (B) to a greater extent catalyzes the aerobic oxidation of the accumulated lactate to pyruvate.

Proceeding from the stated properties of LDH isoenzymes to catalyze the alternative glycolysis pathways, one can suppose that adaptation to winter conditions goes by intensifying its aerobic pathways which allows maintenance of the necessary level of pyruvate and reducing equivalents in the liver and skeletal muscle mitochondria at the expense of the isoenzymes belonging to group B. The latter, as has been shown above, bear a great functional load in winter, since precisely at their expense a fall in the anaerobiosis coefficient took place.

The intensification of the aerobic glycolysis pathways in liver and skeletal muscles in mink and polar foxes with reduction in environmental temperatures can be treated as a peculiar kind of adaptation of the energy exchange and, alternatively, as an addition to respiration mechanism of producing

energy. It should be noted that we have recorded a similar seasonal direction of glycolysis earlier in the level of the isoenzymatic LDH spectra in blood serum, which was in essence a reflection of the changes observed in the tissue level (Kozhevnikova et al., 1988). In this case, a shift in the lactate dehydrogenase reaction towards aerobiosis occurred against the background of a growing share of glycolysis in the total cell energy provision (Berestov, Kozhevnikova, 1989) which agrees with the information by Isaakian (1972) and Haskin (1975) about a more intensive utilization of the glycolytic pathway in the muscles and liver of animals in cold conditions.

In the spring-summer period the role of the aerobic way of the transformation of pyruvate in the lactate dehydrogenase reaction becomes less important (not only a relative content of LDH-1 decrease, but the content of LDH-4 and LDH-5 increases), and the process of carbohydrate decomposition is obviously shifted towards the reduction of pyruvate to lactate which goes on against the background of the reduced total value of glycolysis and intensified heat production and oxygen consumption (Kozhevnikova, Berestov, 1987).

Thus, seasonal rearrangements in the isoenzymatic profile of the acetate dehydrogenase of blood serum, liver, skeletal muscles in mink and polar foxes are manifested in changes in the relation of the activities of the "pure" form of the isoenzyme LDH-5 and LDH-1 dependent on the requirements of the organism to adaptation to environmental factors. All this is indicative of a fine regulation of the biochemical functions at the expense of the system in charge of producing energy. The latter shows up in winter to a greater extent and is manifested in the stimulation of aerobic glycolysis pathways as the most efficient for producing energy.

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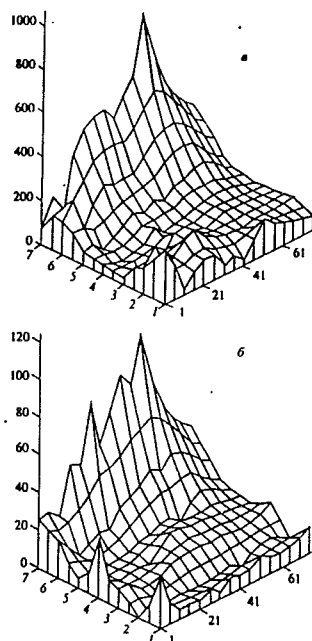


Fig. 1. Changes superoxide dismutase (a) and catalase (b) activity in different minks organs in postnatal ontogenesis.

On abscissae axis - days of postnatal ontogenesis; on ordinate axis - organs (1 - spleen, 2 - brain, 3 - lung, 4 - skeletal muscle, 5 - heart, 6 - kidney, 7 - liver); on applicate axis - activity of enzymes (relative units/g tissue for SOD,  $\times 10^4$  IU/g tissue for catalase).

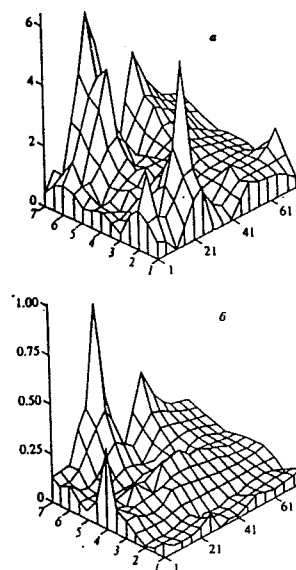


Fig. 2. Changes superoxide dismutase (a) and catalase (b) specific activity in different minks organs in postnatal ontogenesis.

On applicate axis - specific activity of enzymes (relative units/mg protein for SOD,  $\times 10^4$  IU/g protein for catalase). Another designation as in fig. 1.

#### Enzymes of the antioxidant system during postnatal ontogenesis in the mink

V.A. Ilukha



### Enzymes of the antioxidant system during post-natal ontogenesis in the mink

V.A. Ilukha

The activity of the key antioxidant enzymes, superoxide dismutase and catalase, was estimated in various organs of mink (*Mustela vison* Briss.) pups during postnatal ontogenesis. The organ-specific distribution of these enzymes was established and the levels of their activity were matched to certain periods of ontogenesis. This enzymatic system is already formed by the moment of birth, and further changes in it are related to the growth of organs and the effects of environmental factors.

*Ontogenesis (Russian Journal of Development Biology) 26, 2, pp. 115-118, 1995. In RUSS. 2 figs., 18 refs. Author's abstract.*

### Reference data on the anatomy and serum biochemistry of the silver fox

Yao-ming Zhan, Jun Yasuda, Kimehiko Too

Clinically healthy silver foxes obtained from a closed colony were investigated for the purpose of establishing base-line data for this species. The anthropometry (body weight; body length; length and width of the head, width, depth, and circumference of the chest; length of the tail), anatomical measurements (weight; longitudinal and transverse length; thickness of the main organs) and serum biochemical assays (AST, ALT, ALP, LDH, CK, lipase, GGT, T-Cho,  $\beta$ -Lipo, TG, Phos-Lip, Tp, T-Bil, UA, BUN, Crea, Glu, Ca, IP, Mg, Fe, Na, K, Cl, LDH and CK isoenzymes) were carried out. The data were presented as mean values with standard deviations, and compared with those of the dog.

The coefficient of variation (CV) for each of the anthropometric parameters was low, except for that of female body weight for which the CV was 17%. The body size of the male was larger than the female, and the weights of the main organs, corresponding to body size, were greater than the female. The results were equivalent to those for a Beagle dog aged between 3 and 5 months. Significant differences between the sexes were detected in the following parameters: concentrations of BUN,  $\beta$ -

Lipo and T-Bil ( $p < 0.01$ ); concentration of Mg and Glu ( $p < 0.05$ ); activity of LDH and lipase ( $p < 0.05$ ).

The biochemical data were uniform with some exceptions. These were AST (142 IU/l) and ALP (122 IU/l) in a 5-year-old male fox. Glu (over 200 mg/dl) in four 2-year-old female foxes, CK (629 IU/l) in a 2-year-old female fox, and finally CK (366 IU/l) and lipase (428 IU/l) in an 8-year-old female fox, all of which were elevated. These data were similar to the reference values for the dog previously reported.

The reference values presented in this report for the silver fox will be valuable as a guide for clinical diagnosis and research.

*Jpn. J. Vet. Res. 39: 39-50, 1991. 5 tables, 2 figs., 19 refs. Authors' summary.*

### Innate skin growth disturbance in chinchillas

Jan Zwierzchowski, Ewa Smielewska-Los

On a chinchilla farm, where marked decreases in fertility were observed, morphological changes of unknown origin (not reported so far in this species) occurred on the skin of four animals in subcutaneous tissue/hypodermis in the form of oedema (anasarca) on the abdomen. The changes were noticed in three females and one male. All animals were the progeny of the same mother and were related to her in F1, F2, F3, and F4 generations.

Studies were performed on two of the females. No clinical disease symptoms were found; the animals were in good health. In the abdominal and chest regions the oedema was located symmetrically and it felt cold and soft on examination with symmetrically palpable sclerosis (callosity) hardening.

Hematological indices of the blood and the level of serum protein were within standards and tests for parasites proved negative. Bacteriological examination revealed a few colonies of *E. coli*, but colonies of *Proteus* sp. and *Staphylococcus epidermiditis* were isolated from the subcutaneous tissues affected. In one of the females, growth of *Aspergillus* fungus was found and, in the other, the *mucor* type of fungus.

Post mortem examination showed quite large anasarca in chest regions, hypogastrium and groins. Cross-sectional study of the tissue presented congestion and the presence of hard formations filled with greasy substance. Microscopic picture depicted numerous cyst-like forms, the capsule of which was made of epidermis, dermis, sheath of the hair and hair gland. The inside of the cysts were filled with exfoliated epidermis and the remnants of hair. Hypodermis was characterized by numerous widened cavitory veins filled with blood and capillarectasia. Stromal connective tissue was markedly oedematous.

Angiectasia and telangiectasia were of a congenital type. Cystiforms in hypodermis looked like innate/congenital cystes dermoides.

The changes observed may be of hereditary origin because of the same progenitor.

*Only abstract received. Authors' abstract.*

#### **Sex and regional differences in intracellular localization of estrogen receptor immunoreactivity in adult ferret forebrain**

*S.A. Tobet, T.W. Chickering, T.O. Fox, M.J. Baum*

Estrogen receptors were visualized in adult ferret brains using the H222 estrogen receptor antibody and immunocytochemical techniques. H222 immunoreactive (H222ir) cell nuclei were present in many forebrain regions in gonadectomized ferrets of both sexes. In many instances, H222ir cells also had immunoreaction product in their processes. All cells with H222ir processes also contained H222ir nuclei. More H222ir processes were observed in females in the medial and lateral preoptic area/anterior hypothalamus, and at the level of the descending fornix and caudal anterior commissure. Quantitative image analysis confirmed that females had significantly more (approximately 50%) extranuclear H222 immunoreaction product than males in cells in the magnocellular or preoptic subnuclei of the bed nucleus of the stria terminalis. Cells in the principal subnucleus of the bed nucleus of the stria terminalis and ventrolateral septum were notable for the relative paucity of H222ir processes. Sex differences in the intracellular extranuclear distribution of estrogen

receptor protein in particular brain regions might contribute to the differential regulation of estrogen-dependent functions in the two sexes.

*Neuroendocrinology 3, 58: 316-324, 1993. 2 tables, 5 figs., 47 refs. Authors' abstract.*

#### **Time of pelting of silver fox**

*Vilhelm Weiss*

The effects of date of pelting, age, and pelt processing method on pelt quality were investigated on 62 silver fox pelts from 2 farms. The incidence of pelts with hair loss was 30 and 55%, respectively at the 2 farms. The incidence of loose hairs was not significantly affected by litter, age at pelting or method of processing, but was significantly higher for foxes pelted in early than in late December.

*Dansk Pelsdyravl 56 (1): 404-406, 1993. In DANH 1 photo, 2 refs. CAB-abstract.*

#### **Focusing on the time of pelting**

*K.A. Selbekk*

51 silver foxes were pelted on 6 Dec., 21 Dec. or 6 Jan., and their pelts were evaluated before and after processing. Of 23, 14, and 14 pelts from foxes pelted on the 3 dates, none, 4, and 10, respectively, had no loose hairs.

Pelts from foxes pelted on 21 Dec. or 6 Jan. showed a lower degree of hair loss after processing than those from foxes pelted on 6 Dec., but there was no evidence that type of processing had a significant effect on pelt quality.

*Norsk Pelsdyrblad 67 (11): 12-13 + 16, 1993. In NORW. 2 tables, 2 photos. CAB-abstract.*

#### **The advantages of water**

*Janne Hansen*

133 pelts from mink at 2 farms with or without access to shallow water trays in their cages from

Aug. to pelting were compared, and a further 367 pelts were also examined. Pelts from mink with access to water tended to have better clarity than those from animals with no access to water. However, use of water may lead to smaller pelts, higher food consumption and/or a higher bacterial growth in nest boxes.

*Dansk Pelsdyravl* 57, 7: 283-284, 1994. In DANH. 3 tables, 1 fig. CAB-abstract.

### The effect of fertility on the production of fur bearers

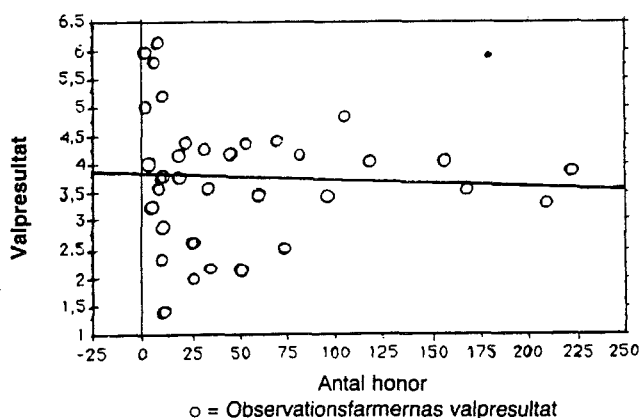
*Kai Rune Johannessen*

Possibilities of improving male and female fertility in mink and foxes by means of management and selection are discussed, and the importance of fertility for economic return is considered.

*Norsk Pelsdyrblad* 67, 9: 4-5, 1993. In NORW. 1 photo. CAB-abstract.

### Effect of farm size on the average litter size

*Pasi Koppinen*



**Fig. 1.** Litter size on farms of different sizes, 1988

In an attempt to provide a method of accurate assessment of the performance of breeding animals at individual farms, the relationship of farm size with litter size was determined, using data on silver fox

females whelping in Finland in 1988. For females at 13 farms with 1-10 breeding females, litter size averaged  $4.09 \pm 1.47$  cubs vs.  $3.75 \pm 0.61$  at 12 farms with 59-222 females.

*Finsk Pälstidskrift* 27, 6-7: 170, 1993. In SWED. 1 fig. CAB-abstract.

### Population of fur bearers in 1994

*Jens Groot*

In 1994, the numbers of breeding females in Denmark were 1,812,970 for mink, 9,167 for blue foxes, 5,605 for silver foxes, 409 for polecats, 185 for raccoon dogs, and 8,282 for chinchillas, and there were 2,783 mink farms and 228 fox farms. Data are tabulated by district, farm size and colour type, and numbers are compared with those in previous years.

*Dansk Pelsdyravl* 57, 6: 239-242, 1994. In DANH. 8 tables. CAB-abstract.

### Local distribution of pelt production in 1992-93

*J. Mäkelä*

In 1992-93, in Finland, the production of mink, fox, raccoon dog and polecat pelts was 1,512,120, 1,226,305, 51,899 and 70,271, respectively. Data are tabulated by district, colour type and farm size. production is compared with that in the previous year, and economic aspects are considered.

*Finsk Pälstidskrift* 27 (12): 310-314, 1993. In SWED. 23 tables. CAB-abstract.

### Work expenditure on fox farms

*Bogumil Strzyzewski*

Work expenditure was determined on the basis of measurements carried out on 8 farms (the picture of the day's work). The measurements were repeated a few times in each of six periods of the year. It has been established that the upkeep of one vixen takes up from 23 to 154 hours of work a year. The extent of work expenditure is affected, above all, by the

size of the herd and in cases of similar herds by the level of mechanization of the farm. In the structure of work expenditure the first place is taken by work connected with feeding foxes (35-63%), thereafter work connected with breeding and veterinary care (15-42%), cleaning (6-27%) and others 14-16%).

*Annals of Warsaw Agricultural University SGGW-AR, Animal Science, No. 25: 53-57, 1990. 3 tables, 3 refs. Author's abstract.*

### **Economic results obtained on fox farms**

*Bogumil Strzyzewski*

The investigation was based on the data collected on 8 fox farms from 1981 to 1984. The costs necessary for the upkeep of one vixen and for obtaining one pelt were determined. Depending on the farm size the costs calculated per one vixen varied from 20.000-30.000 zł to 50.000-60.000 zł. In the structure of costs the feed amounts to 30-50% and the labour cost up to 20%. The index of production profitability for particular years and farms amounted to 110-167 pnts.

*Annals of Warsaw Agricultural University SGGW-AR, animal Science, No. 25: 59-62, 1990. 3 tables, 4 refs. Author's abstract.*

### **Sixty years of fur farming at Lubiechow**

*Mirosław Bochenek*

The Fur Animal Farm at Lubiechow, was established over 60 years ago. Due to outstanding economic and breeding results achieved during that period, it can be considered as one of the best in the country. Unfortunately, the organizational, institutional and system environment existing since 1945 did not allow for full use of available potential material and labor capacities. Those conditions unfavourably influenced the farm's development and, at present, they still determine the existence of the farm. Since the beginning of systematic changes which started at the beginning of the eighties, we expected some improvement of the farm's situation and external conditions. Unfortunately, the results of economic

reforms to date as well as of system transformations may not be considered as encouraging.

*Zeszyty Naukow Akademii Rolniczej w Szczecinie, nauki Spoeczne i Ekonomiczne 30: 3-23, 1992. 5 tables, 6 refs. In POLH. Complete translation into ENGL available. Author's summary.*

### **Long-term effects of different handling procedures on behavioural, physiological, and production-related parameters in silver foxes**

*Vivi Pedersen*

Fifty-one silver fox vixens, subjected to three different handling treatments as cubs (no-handling, gentle or forced handling), were studied for long-term effects on behavioural, physiological and production-related parameters in a one and a half year period following the last handling session. As juveniles, the animals were exposed to three different behavioural tests at 18, 22, 28, and 32 weeks of age. Both forcibly and gently handled animals showed reduced fear responses compared with non-handled controls in test situations involving close contact with humans ( $P < 0.05$ ). The foxes were tested again as adults at 10, 13, 15, and 18 months of age with the same behavioural tests.

It was revealed that forcibly handled animals persistently showed reduced fear responses compared with control animals, both in close contact with humans and when exposed to a novel object, whereas gently handled animals only differed from control animals in one of the tests involving some human contact and when exposed to a novel object ( $P < 0.05$ ). Significant differences between adult gently handled and forcibly handled animals were found in the 'confront' test involving close human contact. In this test more flight responses were observed in the gently handled group than in the forcibly handled group ( $P < 0.01$ ). Control animals had significantly larger adrenal weights compared with both forcibly handled animals and gently handled animals at 22 months of age (total mean adrenal weight: controls, 0.62 g; gentle, 0.54 g; forced, 0.54 g,  $P < 0.05$ , general linear models). Other physiological measures and production-related parameters such as body weight, body size, gastric ulceration and

pelt qualities did not differ between treatments ( $P < 0.05$ ). Early post-weaning handling made foxes less fearful towards humans. Forced handling seemed somewhat superior to gentle handling as a means to produce animals which, in the long term, adapted better to the farm environment both behaviourally and physiologically. Non-handled control animals suffered from long-term stress as reflected by high levels of fear responses and enlarged adrenals. Thus post-weaning handling may be beneficial in the long term for the well-being of farmed foxes. When applied as a management routine, handling had no significant influence on later production-related parameters and was not considered an economic risk.

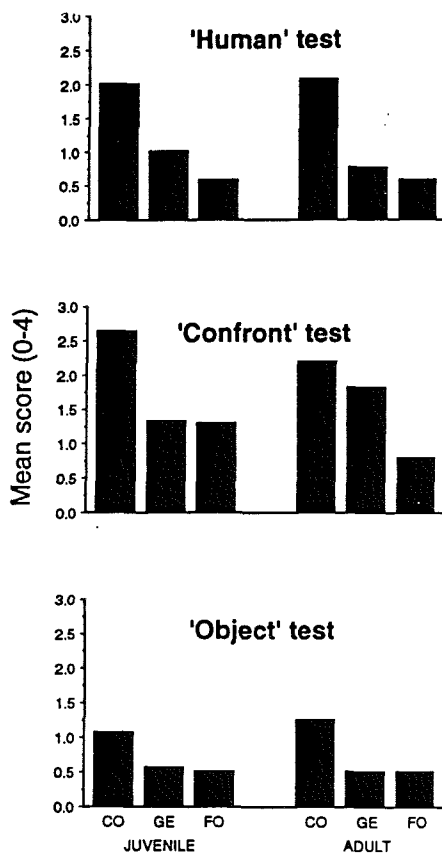


Fig. 1. Flight responses of 51 silver fox vixens when juvenile (left) and adult (right) in response to three tests. The vixens had been subjected to three different early handling treatments (control, CO; gentle, GE; forced, FO).

*Applied Animal Behaviour Science* 40: 285-296, 1994. 1 table, 2 figs., 35 refs. Author's abstract.

### Research on taming and reproduction in fox and raccoon dog

Xu Guiqin, Li Changsheng, Li Yulan

Raccoon dog and fox were tame and docile according to their ecological characters and behaviour pattern so as to set up relative reflection. The results indicated that domestication can improve female reproduction. The survival rate of young raccoon dogs was improved significantly ( $P < 0.01$ ) by t-test.

*Ecology of domestic animal* 14 (2): 6-9, 1993. In CHIN. 2 tables. Authors' abstract.

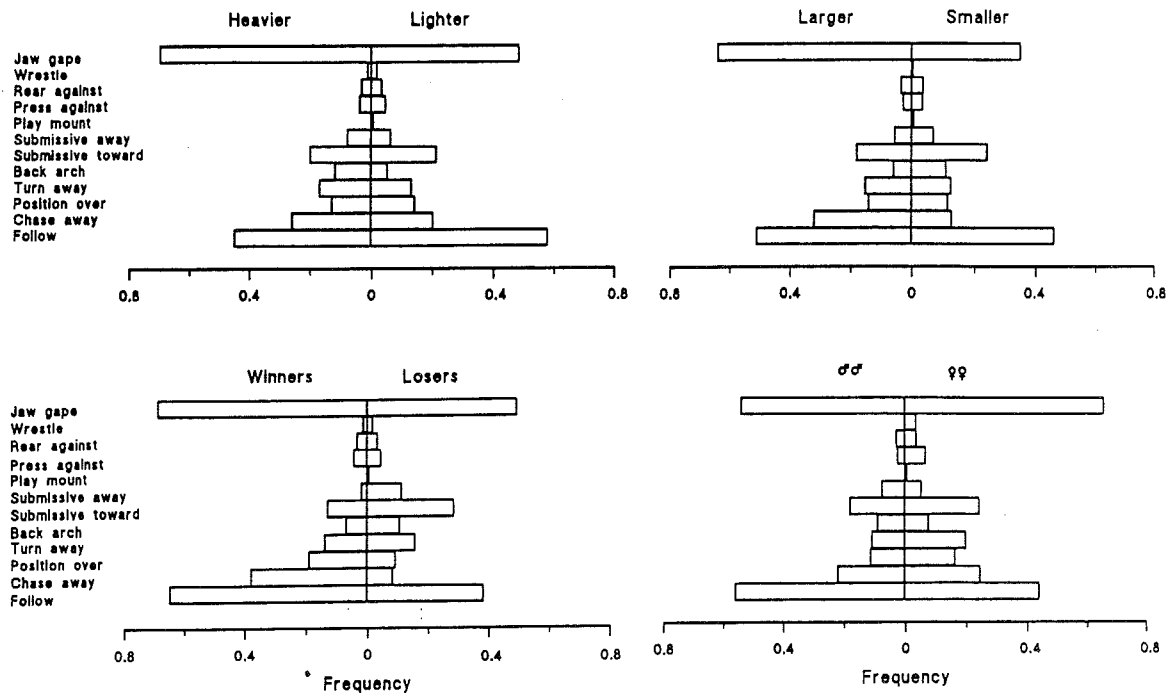
### Seasonal changes in activity of Arctic foxes *Alopex lagopus* L. in Svalbard

Karl Frajford

Daily and seasonal activity patterns of Arctic foxes *Alopex lagopus* were studied on the western coast of Svalbard from 1986 to 1989. The activity of radio collared foxes ( $n=11$ , including two pups) was recorded on a chart recorder, and the activity of litters of pups ( $n=6$ ) was observed in denning areas. Only one collared fox, a female, was known to be breeding. The range in activity by month and individual was about 10-60%, and yearly means were 32% and 36% in adult males and females, respectively. Variation between months was not significant. A seasonal variation was found although no two seasons were different from each other. Average percentage of activity in the summer was 40%, and in the winter 15%. No influence on the rate of activity of temperature and wind speed was found.

Foxes averaged 39% activity in nighttime hours (2000-0800) and 28% in daytime hours (0800-2000) ( $p=0.06$ ). Three adults (two males, one female) and one pup that were monitored when living in the same bird cliffs influenced each others' activity only to a small extent.

*Fauna Norv. Ser. A* 14: 39-46, 1993. 2 tables, 5 figs., 23 refs. Author's abstract.



**Fig. 1.** Mean frequency of behaviours per 5 min of observation of winners vs. losers (Wilcoxon test,  $z=0.87$ ,  $P>0.05$ ), females vs. males ( $z=1.49$ ,  $P>0.05$ ) heavier vs. lighter foxes ( $z=0.85$ ,  $P>0.05$ ), larger vs. smaller foxes ( $z=0.89$ ,  $P>0.05$ ).

### Agonistic behaviour and dominance relations of captive arctic foxes (*Alopex lagopus*) in Svalbard

Karl Frajford

Agonistic behaviour and dominance relations were studied in three groups of arctic foxes (*Alopex lagopus*) on the western coast of Svalbard (79°N): (1) Five 'tame' foxes (3♂♂, 2♀♀) kept in captivity for 9-26 months, (2) twenty-two 'wild' foxes (11♂♂, 11♀♀) kept in captivity for 4 days to 3 weeks, and (3) free-living foxes. Experiments were started by introducing two foxes ( $n=74$  dyads) into a large enclosure (360 m<sup>2</sup>), scoring winners and losers in a competition for food, calculating a dominance index (DI), and observing the frequency of 12 behaviours. DI was correlated with body size as measured by the length of a front foot, but not with body weight. Males dominated females more frequently than vice versa ( $P<0.06$ ). Tame foxes were more playful and less aggressive than wild foxes. Fighting was mostly restricted to chasing and following, and no injuries were seen. When considering all 12 behaviours no significant difference was found between winners

and losers, males and females, larger and smaller, heavier and lighter foxes. However, winners were more frequently following and chasing (i.e. offensive), while losers more frequently behaved submissively. Ignoring (dominant) or evading (subordinate) behaviours were frequent, and no distinct display signalling high social status was found (see figure 1).

*Behavioural Processes* 29: 239-252, 1993. 3 tables, 3 figs., 42 refs. Author's abstract.

### Metabolic adaptation to climate and distribution of the raccoon *Procyon lotor* and other procyonidae

John N. Mugaas, John Seidensticker, Kathleen P. Mahlke-Johnson

Our analysis has illustrated that within Procyonidae there are two distinct modes of metabolic adaptation to climate. One is typified by those species with low  $H_b$ 's (*Bassariscus asturus*, *Nasua nasua*, *Nasua*

*narica*, *procyon cancrivorus*, and *Potos flavus*), and the other by *Procyon lotor* with its higher  $H_b$ . Those with low  $H_b$ 's have more restricted geographic distributions, and, with the exception of *Bassariscus astutus*, they are all confined to tropical and subtropical areas.

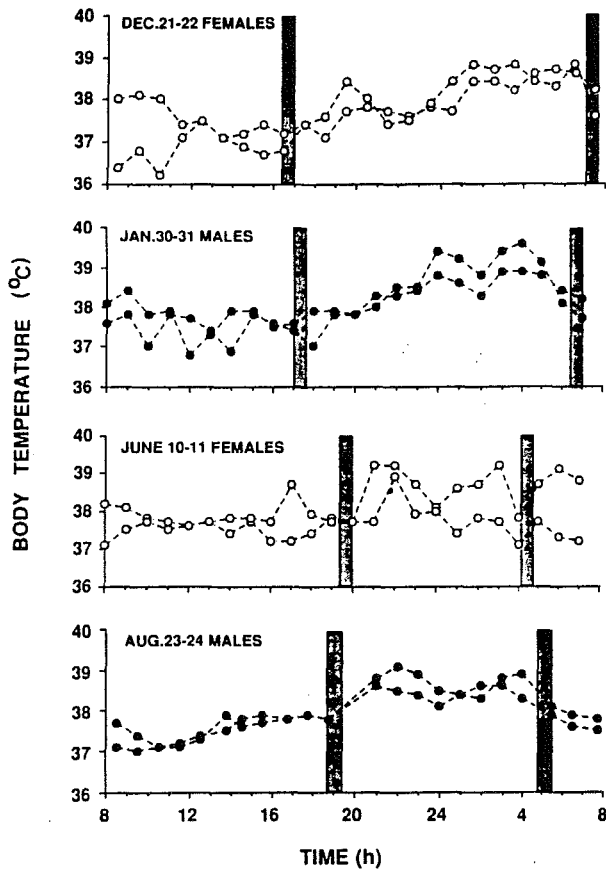


Fig. 7. Relationship between body temperature and time of day at various months of the year: captive females, open circles, captive males, closed circles. Vertical cross-hatched areas represent civil twilight.

The fossil history of this family indicates that it had its origins in tropical forests of North and Central America. This indicates that those procyonids whose distributions are still primarily restricted to tropical forests share many of the metabolic adaptations characteristic of their ancestors. We speculate, therefore, that ancestral procyonids had a lower than

predicted  $H_b$ , a pelt with modest to poor insulative quality, good thermogenic ability but poor heat tolerance, modest to poor capacity for evaporative cooling, no well-defined molt cycle, no cyclic period of fattening, nocturnal habits, and a modestly diverse diet of high-enough quality to provide for an average reproductive potential. Although this pedigree contributed to the success of this family in tropical and subtropical forests, it limited the ability of its members to expand their distributions into cooler, less stable climates. Viewed in this perspective, *Procyon lotor*'s high basal metabolic rate, extraordinarily diverse diet, well-defined cyclic changes in fat content and thermal conductance, high level of heat tolerance, high capacity for evaporative cooling, and high reproductive potential all stand out in sharp contrast to the condition described for other procyonids.

This suggests that the North American raccoon represents culmination of a divergent evolutionary event that has given this species the ability to break out of the old procyonid mold and carry the family into new habitats and climates.

*Smithsonian contributions to Zoology No. 542, 34 pp. 1993. 12 tables, 7 figs., 153 refs. Authors' summary.*

#### Home range and movements of Arctic foxes *Alopex lagopus* in Svalbard

Karl Frafjord, Pål Prestrud

Movements and home ranges of arctic foxes *Alopex lagopus* were studied in two regions of Svalbard by means of radio tracking ( $n=17$ ), ear tagging ( $n=192$ ) and visual observations. The movements of radio collared foxes were highly variable, and most foxes roamed over wide areas at least during periods of the year. Home range size was estimated for 11 foxes when more stationary and for three other less stationary foxes, and were in the range 5-120 km<sup>2</sup>. During non-stationary periods several foxes roamed over areas 500-1000 km<sup>2</sup> or more. These movements may more correctly be classified as nomadic, and should not be termed home ranges. Only 3 of

12 radio collared foxes that disappeared from an area returned later. Seven of the 17 foxes were relocated to the same area in more than one season. Overlap of home ranges was extensive, even more so when a number of non-tagged foxes in the regions were included. The heavier juveniles and adults were more sedentary than those of weight lower than medium.

*Polar Biol* 12: 519-526, 1992. 6 tables, 3 figs., 28 refs. Authors' summary.

### **Arctic fox (*Alopex lagopus*) dens in the Disko Bay area, West Greenland**

*Sussie M. Nielsen, Vivi Pedersen, Bente Bang Klitgaard*

Seventeen arctic fox (*Alopex lagopus*) dens in the Disko Bay area, West Greenland are described regarding location, type, size and vegetation cover. The dens were found in ridges, scree and level ground, mainly in areas of dwarf-scrub heath. The mean number of entrances was  $17.8 \pm 18.4$  SD (range 1-63), with more than half of the dens having fewer than 10 entrances. For dens in slopes, there was a prevalence for south-facing slopes, but for dens with an open exposure, entrances were most frequently oriented towards the north and east.

The dens were not found to be lush green, as reported from several other areas. A visual difference between the den vegetation and the surrounding vegetation could only be recognized at a few den sites.

A vegetation analysis revealed a significant difference between the den and the surrounding area in the occurrence of eight plant species. Among the species occurring more frequently on the den than in the adjacent area, *Stellaria longipes* was the most conspicuous because of its white flowers. This species is therefore suggested as a guide species in the search for new dens in the Disko Bay area. Dens with recent fox activity were larger and more conspicuous than dens without sign of recent activity.

*Arctic*, Vol. 47, No. 4: 327-333, 1994. 2 tables, 3 figs., 30 refs. Authors' abstract.

### **Dominance relations in captive groups of adult and juvenile arctic blue foxes (*Alopex lagopus*)**

*Hannu Korhonen, Sakari Alasuutari*

Dominance relationships were studied in captive Arctic blue fox (*Alopex lagopus*) groups comprising adults (four males, five females) and juveniles (four males, five females). The results showed that Arctic blue foxes easily formed a social organization with an observable hierarchy, in which adults typically dominated over juveniles. Within the same age group, males usually dominated over females. Dominance correlated most significantly with body weight in autumn, but later that correlation decreased. Urine marking activity was very low during autumn and early winter, but increased significantly prior to and during the breeding season when aggressive encounters were also most pronounced. In addition to several adults, the social status of some juveniles was high at breeding time. Altogether 7 out of 11 females (63.6%) whelped, but the survival rate of litters was low and kits of only two adult females survived (18.2%). It can be concluded that hierarchical development and reproduction in Arctic blue fox groups are markedly influenced by dominance relationships.

*Polar Biol* 15: 353-358, 1995. 3 tables, 22 refs. Authors' abstract.

### **Contaminants in fishes from Great Lakes-influenced sections and above dams of three Michigan rivers. II: implications for health of mink**

*J.P. Giesy, D.A. Verbrugge, R.A. Othout, W.W. Bowerman, M.A. Mora, P.D. Jones, J.L. Newsted, C. Vandervoort, S.N. Heaton, R.J. Aulerich, S.J. Bursian, J.P. Ludwig, G.A. Dawson, T.J. Kubiak, D.A. Best, D.E. Tillitt*

Populations of mink (*Mustela vison*) have declined in many areas of the world. Such declines have been linked to exposures to synthetic, halogenated hydrocarbons. In the Great Lakes region, mink are fewer in areas along the shore of the Great Lakes and their tributaries where mink have access to fish from the Great Lakes. Recently, there has been



discussion of the relative merits of passage of fishes around hydroelectric dams on rivers in Michigan. A hazard assessment was conducted to determine the potential for adverse effects on mink, which could consume such fishes from above or below dams on the rivers. Concentrations of organochlorine insecticides, polychlorinated biphenyls (PCBs), 2,3,7,8-tetrachlorodibenzo-*p*-dioxin equivalents (TCDD-EQ), and total mercury were measured in composite samples of fishes from above or below hydroelectric dams on the Manistee and Muskegon Rivers, which flow into Lake Michigan, and the Au Sable River, which flows into Lake Huron. Concentrations of organochlorine insecticides, PCBs, and TCDD-EQ were all greater in fishes from below the dams than those from above. Concentrations of neither organochlorine insecticides nor mercury in fishes are currently a risk to mink above or below the dams. All of the species of fishes collected from downstream of the dams contained concentrations of PCBs and TCDD-EQ, which represent a hazard to mink. The hazard index for PCBs was less than one for the average of all species from the upstream reaches of the Manistee and Au Sable rivers, but not the Muskegon. The hazard index (concentration in fish/NOAEC) was greater than 1 for all of the species collected from below the dams, in all three rivers. The greatest hazard index was observed for carp (*Cyprinus carpio*) downstream on the Muskegon River. Because the concentrations of PCBs used in the hazard assessment were corrected for relative toxic potencies, the hazard ratios based on PCBs should be similar to those based on TCDD-EQ. This was found to be true. Thus, either total PCBs or TCDD-EQ could be used as the critical toxicant in the hazard assessment. However, if uncorrected concentrations of PCBs, expressed as Aroclors®, were used in the hazard assessment, the toxicity of the weathered mixture would have been underestimated by approximately five-fold, and, in that instance, TCDD-EQ would be the critical contaminant for the hazard assessment. The average maximum allowable percentage of fish from above the dams, which would result in no observable adverse effects of TCDD-EQ, was 70%. Based on the average TCDD-EQ concentrations in the fishes, an average of 8.6% of the diet could be made up of fishes from below dams on the rivers. The most restrictive daily allowable intakes were for carp on the Muskegon and steelhead trout (*Onchorhynchus mykiss*) on the Manistee Rivers. Only 2.7% of the diet could be

made up of these two species from below dams without exceeding the no-effect concentration. This would represent approximately 15 days of food intake. Currently, consumption of all species of fish from below the dams, would pose some risk to mink. The concentrations of PCBs and TCDD-EQ in fishes from below the dams were 10-20 times more hazardous, on average, than those from above the dams.

*Arch. Environ. Contam. Toxicol.* 27: 213-223, 1994. 7 tables, 1 fig., 76 refs. Authors' abstract.

#### **Immobilization of captive raccoon dogs (*Nyctereutes procyonoides*) with medetomidine-ketamine and remobilization with atipamezole**

*Jon M. Arnemo, Randi Moe, Adrian J. Smith*

Eight captive raccoon dogs (*Nyctereutes procyonoides*) were immobilized with medetomidine HCl (MED) 0.1 mg/kg and ketamine (KET) 5 mg/kg i.m. in a crossover study. In group I, the animals were left to recover spontaneously, and in group II, the animals received atipamezole HCl (ATI) 1 mg/kg i.m. for reversal 20-25 min after the MED/KET injection. MED/KET rapidly induced complete immobilization in both groups. The induction times were  $3.3 \pm 0.2$  ( $\bar{x} \pm \text{SEM}$ ) and  $3.4 \pm 1.1$  min in groups I and II, respectively. Both the corneal and pedal withdrawal reflexes were absent in immobilized animals, and the mean times to reappearance of these reflexes in animals recovering spontaneously were  $90.3 \pm 8.6$  and  $102.4 \pm 10.0$  min, respectively. In group I, the mean rectal temperature dropped from  $36.8 \pm 0.2^\circ\text{C}$  to  $35.4 \pm 0.1^\circ\text{C}$  recorded 5 and 90 min after the MED/KET injection, respectively, and the mean heart rate dropped from  $110.0 \pm 5.7$  to  $75.0 \pm 6.4$  beats/min at the corresponding times. All animals had irregular respiratory patterns, with intermittent periods of apnea and tachypnea shortly after immobilization. Respiratory patterns became more regular during the immobilization period (group I) and the mean respiration rate increased from  $7.9 \pm 0.7$  to  $18.0 \pm 2.3$  breaths/min recorded 20 and 90 min after the MED/KET injection, respectively. Administration of ATI markedly shortened the recovery of immobilized animals without apparent side effects. The mean time from ATI injection to when the animals were able to

walk was  $15.9 \pm 2.3$  min. In animals left for spontaneous recovery the mean time from MED/KET injection to when the animals were able to walk was  $129.3 \pm 7.0$  min. Medetomidine and ketamine can be recommended for immobilization of captive raccoon dogs; induction is rapid, there are few side effects, and the animals can be remobilized with atipamezole.

*Journal of Zoo and Wildlife Medicine* 24 (2): 102-108, 1993. 2 tables, 33 refs. Authors' summary.

### **The husbandry of ferrets**

G. Allmacher

In order to aid in the critical examination of the husbandry of ferrets a survey is given on the methods of keeping these animals as helpers for hunting; house pets or laboratory animals. The special requirements of ferrets regarding their care and housing are described.

*Dtsch. Tierärztl Wschr.* 101: 81-132, heft 3, 1994. In *GERM*. Author's summary.

### **Circumpolar size variation in the skull of the arctic fox *Alopex lagopus***

Karl Frajford

Eleven skull and mandible dimensions were measured in arctic foxes, *Alopex lagopus*, from Fennoscandia, the Far East (Siberia), Baffin Island (Canada), Greenland, Jan Mayen and Svalbard ( $n=278$ ), and comparisons with data from the literature were made, including samples from most parts of the species' circumpolar range. Significant differences between regions were found, notably Fennoscandian and Siberian foxes were larger than foxes from Greenland, Jan Mayen and Svalbard. Overall skull size was reduced with increasing latitude, which may indicate energetic constraints on body size in high latitudes due to a lower primary productivity.

*Polar Biol* 13: 235-238, 1993. 3 tables, 1 fig., 20 refs. Author's abstract.

### **Directions for the correct use of zoologically relevant species names for our domesticated and laboratory animals, with reference to the current latin names of their parent species**

W. Meyer, T. Bartels, K. Neurand

This study is concerned with the correct use of the scientific zoological nomenclature for domesticated and laboratory animals. With the help of four tables and the most current latin names of all important domesticated animals (animals of economic importance, ranch-bred animals, companion animals, fancy animals, laboratory animals) are given.

The authors suggest a formal nomenclature for domesticated animals which should principally be related to the scientific name of the parent species (binominally and in italics), as always followed by the completion "forma domestica / f. dom." (not in italics). Problems arising from the use of such scientific names when hybridization and introgression is concerned are also discussed, and appropriate nomenclature is proposed.

*Schweiz. Arch. Tierheilk.* 135: 156-164, 1993. In *GERM*. 38 refs. Authors' summary.

### **Environmental acceptability test for animal production units**

Wilfried Eckhof, Ewald Grimm, Andreas Hackeschmidt, Volkmar Nies

Procedures for assessing the environmental acceptability of animal housing in Germany are presented based on current understanding of environmental impact, existing legislation and practicable evaluation methods. Evaluation criteria and check-lists are given.

*KTBL-Arbeitspapier No. 189*, 153 pp., 1994. 50 refs, many tables and figs. Darmstadt, Germany; *KTBL Kuratorium für Technik und Bauwesen in der Landwirtschaft*, ISBN 3-7843-1829-0. In *GERM*. CAB-abstract.

### Data on the role of otter (*Lutra L.*) in pond farming

J. Lanszki, S. Kormendi

Examinations have been made for a one year period on a 12 ha delimited fish pond which can be considered as a model. The food composition of the otter has been examined by spraints analysis on 166 spraints.

Otters feed predominantly on fish. The relative frequency per cent of the latter is 75.1% in a year average. There was no pike perch in the fish food. The rate of the carp - as main fish - was at high value in winter and in summer in the period following the netting and preceding the introduction of the fish. In the main fish producing period the main fish could be found at a low rate in the food of the otter while weed and incidental fish had a rate of 77.8-85.7%.

Observations show that otter gets its nutrition mainly in shallow coastal water in summer and autumn. Preyed carp belonged to the 200-300 g range of sizes.

The authors' proposals aim to decrease damages due to otters in fish ponds.



Halaszat 86, 4: 190-191, 1993. In HUNG, Su. ENGL. 1 table, 1 fig., 2 photos, 5 refs. Authors' summary.

### Prolactin receptor concentrations in the skin of mink during the winter fur growth cycle

Jack Rose, Todd Garwood, Basem Jaber

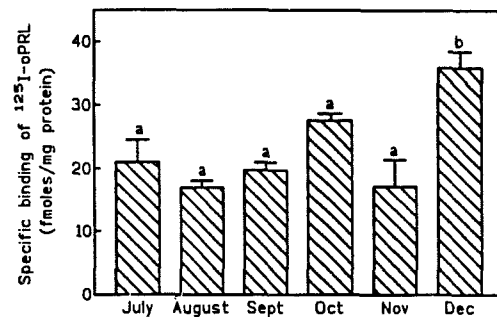


Fig. 3. Concentrations of <sup>125</sup>I-oPRL receptors in the skin of mink collected monthly from July through December 1992. Each value represents the mean ( $\pm$ SEM) of three trials (N = 3 for each trial). Bars with different letters are significantly different at  $P < .05$ .

The objectives of this study were to determine: 1) if the skin of mink might be a target organ for prolactin (PRL) by establishing if PRL binding sites (receptors) exist in the cell membranes of skin, and 2) if PRL receptor concentrations change during the onset and progression of the winter fur growth cycle. Skin was collected on October 6, 1992 for characterization of PRL receptors and from July through December 1992 (N = 3 mink/month) to evaluate possible changes in PRL receptor concentrations during the fur growth cycle. PRL receptors were quantified using <sup>125</sup>I-oPRL in a validated radioreceptor assay. Scatchard analysis of saturation data revealed a single class of high-affinity ( $K_d = 5.21 \times 10^{-11} \pm .84$  M), low capacity ( $B_{max} = 27.03 \pm 3.37$  fmoles/mg) binding sites. Only oPRL (40% displacement) and to a lesser extent oGH (3% displacement) inhibited the binding of <sup>125</sup>I-oPRL to mink skin cell membranes. No inhibition of <sup>125</sup>I-oPRL binding to membranes occurred in the presence of a 500-fold excess of bTSH or oLH, indicating that the receptors were hormone specific. Concentrations of <sup>125</sup>I-oPRL receptors during the onset and development of winter fur growth (July through November) exhibited no significant change. However, following completion of the winter fur growth cycle (December 1) PRL receptor concentration was significantly higher than all preceding months. The greater binding observed at that time may reflect a change in tissue sensitivity, in pre-

paration for growth of the summer pelage. These data suggest to us that the skin of mink is a target organ for PrL and are consistent with the hypothesis that part of the effects of PRL on fur growth occur directly at the level of the skin.

*The Journal of Experimental Zoology* 271, pp 205-210, 1995. 3 figs., 35 refs. Authors' summary.

### Effects of adrenalectomy (ADX) and exogenous testosterone (T) or dihydrotestosterone (DHT) on the initiation of hair growth cycles and prolactin receptor concentrations in the skin of mink

*Brady K. Cottle, Jack Rose, Michael D. Kennedy*

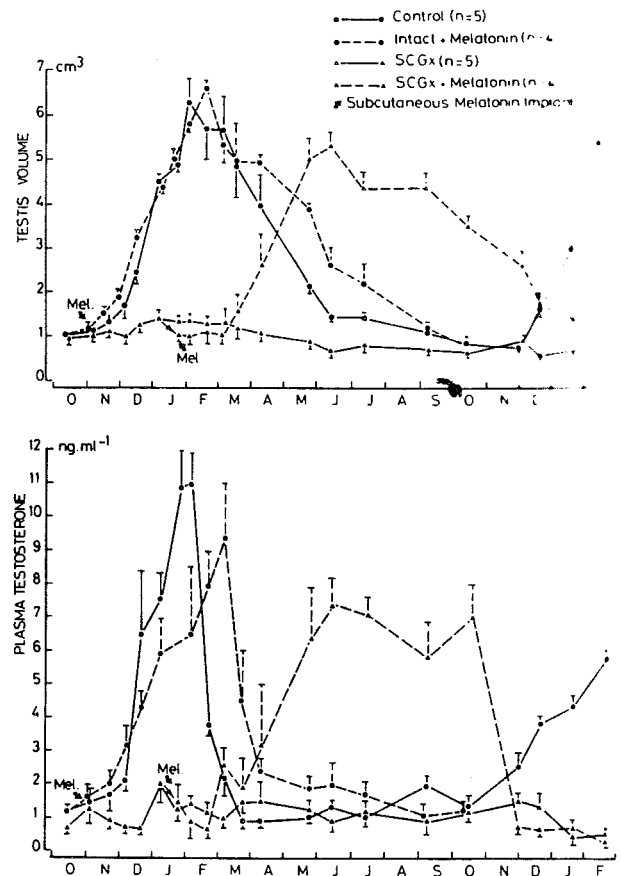
Recently, we demonstrated the presence of PRL binding sites in mink skin, suggesting a direct action of the peptide on hair follicles. Because ADX induces hair growth, it is possible that the actions of adrenal hormones are mediated, in part, through changes in skin PRL receptor concentrations. This study was conducted to determine: 1) if the PRL binding capacity of mink skin was influenced by ADX, 2) if ADX induced hair growth could be overridden by exogenous T or DHT, and 3) if ADX plus exogenous T or DHT would influence the PRL binding capacity of skin. Mink that were ADX'd (N=4) exhibited hair growth 5 weeks earlier than controls (N=4;  $P<0.01$ ). Neither T (N=3) nor DHT (N=3) delayed the onset of growth immediately following ADX. After completion of the hair growth cycle in all ADX mink, a second hair growth cycle was observed which began immediately without any apparent resting (Telogen) stage. Interestingly, the second hair growth cycle following ADX began 12 days earlier in mink treated with T than ADX's mink treated with or without DHT ( $P<0.05$ ). The concentrations of PRL binding sites in mink skin in September were not altered by ADX, exogenous T or DHT. In November, PRL binding was higher in ADX mink supplemented with DHT than controls ( $P<0.05$ ) but not of ADX mink treated with or without T. In addition, PRL binding capacity was higher in November than September ( $P<0.05$ ) in ADX mink supplemented with DHT. It would appear that ADX induced hair growth is not mediated through a change in PRL binding to mink skin, although we did not distinguish between PRL binding to hair follicles versus

the entire epidermis. The apparent stimulatory effect of T during the second hair growth cycle and the higher PRL binding following DHT treatment may have resulted from differential metabolism of the steroids in the skin as a result of the expected lower serum PRL concentrations in November.

*Western Regional Conference on Comparative Endocrinology 23-25 March 1995, University of Washington. Only abstract received. Authors' abstract.*

### Short-day stimulation of testicular activity and immunoreactivity of the hypothalamic GnRH system in mink following deafferentation of the pineal body by bilateral superior cervical ganglionectomy and melatonin replacement

*Daniel Maurel, Line Boissin-Agasse, Gisèle Roch, Jean Boissin*



**Fig. 3.** Long-term effects of ganglionectomy and subcutaneous melatonin implants on testicular activity (T.V., testis volume; P.T., plasma testosterone level) in intact and ganglionectomized mink reared in a natural photoperiod.

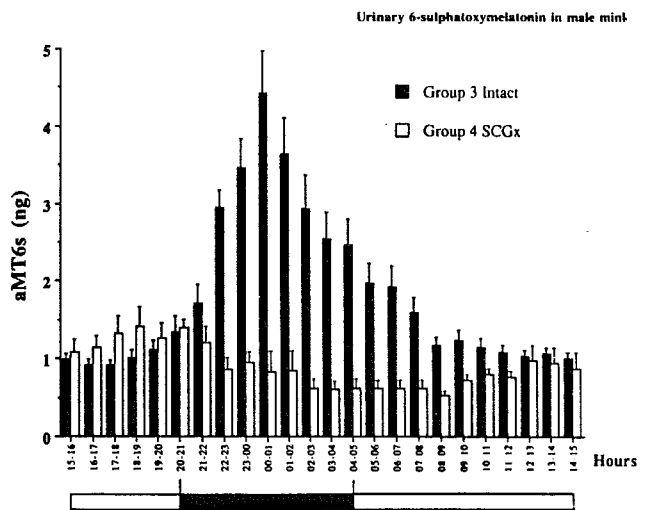
The effects of superior cervical ganglionectomy on testicular function (testis volume and plasma testosterone levels) and the immunocytochemical activity of the GnRH hypothalamic system were studied in the mink, a short-day breeder. Animals reared in a natural photoperiod were (i) ganglionectomized at four different times during the period extending from the end of summer to the end of autumn (September 15, October 20, October 28, and December 1), and (ii) reared for 50 days in a short gonadostimulatory photoperiod (4L:20D). Lastly, an attempt was made to overcome the effects of superior cervical ganglion removal by administering melatonin to mink reared in a natural photoperiod. In mink reared in a natural photoperiod, deafferentation of the pineal on September 15 (L = 12.5 h) or October 20 (L = 10.5 h) resulted in consistently low values of testicular volume and plasma testosterone until the end of the experiment (February). When the operation was performed on October 28 (L = 10 h) testicular activity was initiated but only lasted a short time and did not allow maximal gonadal development. When superior cervical ganglionectomy was carried out on December 1 (L = 8.5 h), during the phase of renewed testicular activity, the increases in testicular volume and testosterone levels were not affected by the operation and the subsequent variation of these parameters was identical to that observed in intact animals. Similarly, in mink reared for 50 days in a photoperiod of 4L:20D before superior cervical ganglionectomy, deafferentation of the pineal did not prevent gonadostimulation induced by short days. These results show that once the hypothalamic system secreting GnRH is triggered by short days, its activity is no longer controlled by the photoperiod. The immunohistochemical study of GnRH-secreting hypothalamic neurons, carried out in December without prior colchicine treatment in animals ganglionectomized in September or October, showed the presence of only a small number of GnRH-positive perikarya. Similarly, positive axonal endings in the external layer of the median eminence were scarce and weakly immunoreactive. On the other hand, in intact animals, in those ganglionectomized on December 1, and those exposed to the short photoperiod of 4L:20D, perikarya and immunoreactive endings were numerous and intensely labeled. In mink ganglionectomized in October (L = 10.5 h) and thereby maintained in a phase of sexual quiescence, insertion of melatonin

implants in January triggered testicular activity 50 days later.

*Brain Research 578, pp 99-106, 1992. 4 figs., 23 refs. Authors' summary.*

### Diurnal variations of urinary 6-sulphatoxymelatonin in male intact or ganglionectomized mink

*D. Maurel, N. Mas, G. Roch, J. Boissin, J. Arendt*



**Fig. 5.** 24 hr variations (mean  $\pm$  SEM) in urinary aMT6s measured in intact (group 3, n = 5) or ganglionectomized (SCGx, group 4, n = 3) mink maintained under an experimental photoperiodic regimen (LD 15:9) for one month.

The existence of the major urinary metabolite of melatonin, 6-sulphatoxymelatonin (aMT6s), was validated for mink and the 24 hr urinary excretion pattern was determined in intact and superior cervical ganglionectomized animals under different photoperiodic conditions. Within- and between-assay variations, parallelism between serially mid-night pooled urine dilutions and standard curves in aMT6s free urine of mink at 1:125 dilution and recovery of aMT6s in mid-day pooled urine at 1:125 dilution provided a good validation for the mink urinary aMT6s assay. In natural photoperiods (January, LD 9:15; April, LD 13:11) the diurnal rhythm was characterized by low aMT6s values during the day and high value at night. There were no differences in the nocturnal values measured under long -

(April,  $4.11 \pm 0.40$  ng/hr) or short-day (January,  $4.74 \pm 0.36$  ng/hr) conditions. In an experimental long photoperiod (LD 15:9), the same result was obtained on the 24 hr rhythm in intact animals, but in ganglionectomized mink the nocturnal rise in aMT6s was abolished and the nocturnal values were always low ( $0.88 \pm 0.09$  ng/hr). Our results agree with those obtained in other species concerning plasma melatonin rhythm and urinary aMT6s excretion; we thus conclude that this is an effective assay for measuring pineal activity in mink.

*J. Pineal Res* 13, pp 117-123, 1992. 1 table, 5 figs., 41 refs. Authors' summary.

#### Concentrations of some mineral elements in the mink body in the period of fur maturity

*D. Mertin, K. Süvegová, E. Oravcová, P. Sviatko*

Concentrations of Co, Cu, Mn, Zn, Ca, Mg, K, Na, Cd, Fe and Pb were investigated in the bodies of young mink in the period of fur maturity. In a trial 24 males and 15 females were used which came from the Farm of Fur-bearing Animals of the Research Institute of Animal Production at Nitra. The animals were clinically healthy, in adequate condition with good-quality fur. They were raised in cages made of galvanized wiring of standard type in two-row shelters. They received normal feed rations which covered their needs with respect to the content of main nutrients.

In the period of fur maturity the animals were skinned out. The cadavers were homogenized, and an average sample of 200 g was taken from each. The samples were analyzed using atom absorption spectrophotometry.

The values of the concentrations of the investigated mineral elements were processed as basic variation-statistical characteristics ( $\bar{x} \pm s$ ). Significance of arithmetical means was tested by *t*-test.

We found significant differences in the concentrations of some investigated mineral elements between the males and females. The males had significantly higher ( $P \leq 0.01$ ) contents of Na (6,719.140 and

1576.360 mg/kg) and Pb (2.037 and 0.822) than the females. Highly significant differences were determined in the females in the concentrations of Co (0.289 in the males, 0.594 mg/kg in the females), Mn (1.709 and 3.360 mg/kg, resp.), Ca (10,345.7 and 13,975.0), Cd (0.315 and 0.473), Fe (211.940 and 247.491), and at a significance level  $P \leq 0.05$  in the concentrations of Zn (67.487 and 70.431 mg/kg) and K (4,174.660 and 4,555.050 mg/kg).

We did not find any significant differences in the concentrations of Cu and Mg. The copper content varied from 6.493 to 6.600 mg/kg and the Mg content from 679.603 to 740.333 mg/kg.

In absolute values, the highest concentrations both in the males and females were found in Ca (10,345.7 to 13,975.0 mg/kg), Na (1,5766.4 to 6,719.1) and K (4,174.6 to 4,555.1 mg/kg). The lowest contents were in Cd (0.315 to 0.473 mg/kg), Co (0.289 to 0.594 mg/kg) and Pb (0.822 and 2.037 mg/kg).

*Zivoc. Vyr.* 39 (2), pp 121-127, 1994. In CHECH, Su. ENGL. 4 tables, 7 refs. Authors' summary.

#### Morphometry of small intestine walls in muskrat (*Ondatra zibethica* L.)

*H. Jackowiak*

The work presents the results of morphometric studies of the walls of small intestines of 7 adult muskrats (800-900 g). In the successive sections of small intestine, changes in the mucosa and muscular layers were found and determined. In the mucosa of the distal sections of the small intestine it was found that together with the decrease of the length of villi, there follows an increase of the length of intestinal crypts. The observations have shown an increased density of goblet cells on the villi and intestinal crypts of the ileum. The increase of the muscular layer in muskrat takes place by the increase of the thickness of its circular muscle layer.

*Roczniki Akademii Rolniczej w Poznaniu - CCXXXIX*, pp 59-66, 1992. In POLH, Su. ENGL. 2 tables, 11 refs. Author's summary.

### Comparison of production results between blue foxes housed with and without platforms

Hannu Korhonen, Paavo Niemelä

The production results of farmed blue foxes (*Alopex lagopus*) housed in cages with and without resting platforms were compared. No differences in weight gain or reproductive performance were found between the groups. However, locomotor activity prior to the breeding season tended to be slightly lower in animals provided with platforms. Platform use during the period of winter fur development (Oct-Nov) varied for the different platform constructions, being highest in wooden U-type platforms placed 30 cm from the cage roof (54.1% of observations on platforms) and lowest in the corner platform type (12.6%,  $p < 0.001$ ). Use of platforms made of wire mesh (45.2%) did not differ significantly from that of the wooden U-types. Ceiling and construction material affected platform dirtiness. The proportion of clean platforms was lowest (35.7%) when the platform was 30 cm from the roof. Net platforms remained very clean throughout the study. The time required for cleaning was greatest in August, ranging from 82 seconds/platform/week for the U-30 type to 2 seconds for the net type. Fur quality ( $p < 0.001$ ) and clarity ( $p < 0.001$ ) had a significant, but negative, correlation with platform dirtiness. The condition of almost all the wooden platforms deteriorated over time due to chewing. Wire mesh platforms were not chewed on. From the farmer's point of view, wire mesh seems to be preferable to wood as a platform material.

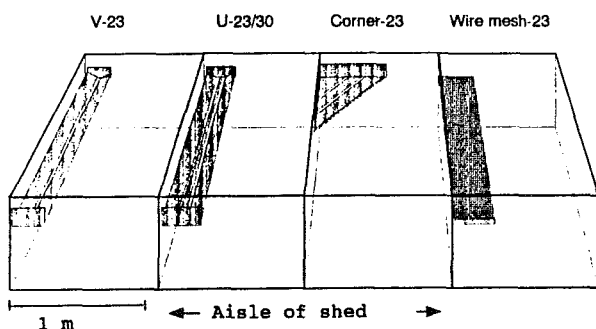


Fig. 1. Schematic pictures of platform types studied.

*Agricultural Science in Finland*, Vol. 4, pp 351-361, 1991. 5 tables, 2 figs., 20 refs. Authors' summary.

### Field immobilization of raccoons with ketamine hydrochloride and xylazine hydrochloride

Jerrold L. Belant

A 5:1 combination of ketamine hydrochloride (KH) and xylazine hydrochloride (XH) was used to immobilize raccoons *Procyon lotor* (Linnaeus, 1758).

Ten raccoons were intramuscularly injected a total of 11 times with dosages between 22.0 to 38.2 mg/kg KH and 4.4 to 7.6 mg/kg XH. Mean ( $\pm$ SE) induction time ( $3.4 \pm 0.5$  min), recovery time ( $101.2 \pm 27.8$  min), and resting heart rate ( $92 \pm 7.6$  bpm) were similar to values reported for captive raccoons immobilized with 10 mg/kg KH and 2 mg/kg XH. Mean body temperature decreased  $1.3^\circ\text{C}$  between 0 and 20 min post-recumbency. Respiration ( $23 \pm 4.0$ ) was generally deep and consistent. A mixture of 5:1 KH/XH is a suitable immobilizing agent for wild raccoons during field studies.

*Acta Theriologica* 40 (3), pp 327-330, 1995. 1 table, 19 refs. Author's summary.

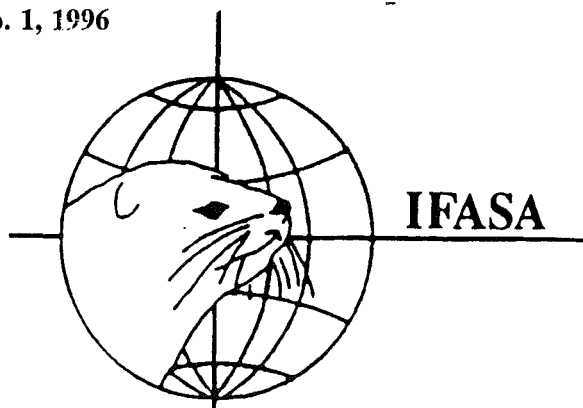
### Body size of Chilean foxes: a new pattern in light of new data

Jaime E. Jiménez, José L. Yáñez, Elier L. Tabilo, Fabián M. Jaksic

By using body measurements and weight data of culpeo fox *Dusicyon culpaeus* Molina, 1782 and chilla fox *D. griseus* Gray, 1837 from the Chinchilla National Reserve (north-central Chile) and Torres del Paine National Park (southern Chile), the body size distribution of Chilean foxes was analyzed and compared to data previously published by Fuentes and Jaksic (1979). Contrary to those authors, our data show that not only the larger but both species increase in size in southern Chile.

Thus, latitudinal size distribution of *D. culpaeus* and *D. griseus* may not be the result of character displacement through exploitation competition, as previously interpreted, but of bioenergetic adaptations.

*Acta Theriologica* 40 (3), pp 321-326, 1995. 1 table, 19 refs. Authors' summary.



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*Original Report*

## **Simulation of a Mink Breeding Programme.**

*Ejner Børsting*

*Managing Director, ScanBrid Int. A/S, Læskovvej 235*

*DK-4632 Bjæverskov, Denmark.*

### **Summary**

The broiler breeding plan at ScanBrid Int. has been designed to be used in simulation experiments. The plan is similar to a mink breeding program, so a special mink model has been developed for a PC.

The mink model is called MINKSIM, and it can simulate selection in a mink population for litter size, pelt quality and body weight.

Population parameters describe the mink type to work with and selection parameters control how the selection is done. The user designs the selection experiment by filling in the parameters in a start-up input screen.

The simulation method is stochastic. Therefore the results have to be based on replicate lines, and the results are presented as average progress for all lines.

The model can be used in actual planning of selection, and an example from the 1995 grading and selection season shows the value of the model as a decision making tool.

### **A modern tool for the planning of breeding schemes.**

Computer simulation is an artificial representation of a real system, where a model is set up to reflect a dynamic system in the real world. The model will be a sort of simplified version of the real system, but experiments on a computer model can be advantageous if real experiments

- are expensive
- take a long time
- are dangerous.

A simulation model can range from a simple budget model to very complex ones using many hours to run on a big mainframe computer.

A simulation model is a very useful tool to analyse the genetic progress in a mink population affected by artificial selection. The population is influenced by both random and systematic effects.

The random effects are the inheritance of breeding values from generation to generation, and the systematic effects are the selection priorities given by

the breeder as he selects breeding animals for a new generation.

There are two simulation methods:

- 1) Stochastic simulation (Monte Carlo)
- 2) Deterministic simulation.

Some of the differences between the two methods are:

Stochastic

Simple programming  
 Calculates means and standard deviations  
 Uses much computing time  
 All replicates give different results

Deterministic

Very complex programming  
 Calculates means  
 Uses moderate computing time  
 All replicates give the same results.

A mink breeding model can be brought on a form, which will run on a normal PC with an acceptable response time.

**The Mink Model**

The mink model is a stochastic model, and it can simulate a breeding programme with selection for litter size, pelt quality, and body weight.

The simulation is controlled by two sets of parameters:

a) the population parameters.

- phenotypic standard deviation
- phenotypic correlations
- genetic correlations
- heritabilities.

b) the selection parameters.

- population size
- mating ratio
- percentage second year females
- percentage males and females culled at weaning time
- percentage males and females culled for body weight before grading for quality
- number of replicates
- number of selection cycles (years)
- relative economic weights for the three traits.

```

SIMULER
Command ==>
                                S C A N S I M
                                Name:  Test 1
Heritability      Litter siz.  Quality      Weight
                   0.15         0.25         0.30
STD               1.50         1.25         250
Correlations
                   Phenotypic      Genetic
Litter siz.      Quality  Weight  Quality  Weight
Quality          -0.02   -0.13   -0.04   -0.10
                  -0.18   -0.20
Litter siz at start: 5
Per group Males: 8      Females: 40  Young fem.: 25
Pct keep after weaning Males : 100  Females: 100
Pct keep after weighing Males : 100  Females: 100
Number replicates: 5      Years : 10
Relative
economic weights  Litter:0.30  Quality:0.40  Weight:0.30
    
```

Fig. 1. Input screen for simulation parameters

Year	Line 1	Line 2	Line 3	Line 4	Line 5	All lines
1	0.000	0.000	0.000	0.000	0.000	0.000
.						
5	0.040	0.031	0.034	0.043	0.036	0.037
.						
10	0.112	0.089	0.110	0.098	0.108	0.103

**Fig. 2.** Output from SCANSIM simulation program. Inbreeding for all replicate lines

Selection indices are calculated on own, full-, and half-sib information for quality and weight on both sexes. As litter size is only expressed in the females the dam's information is also used in the index calculation. The mink model is programmed in SAS and structured in five macros, where the first macro asks for the parameters as shown in figure 1.

### Selection experiments

The simulation can be seen as a type of selection experiment. The same results may not be seen in a real selection experiment, because all factors can be controlled in the computer unlike the situation in a population of live animals. In a real selection experiment the results are often compared to a control line, and the results are expressed in relation to the control line.

When one uses the simulation model in a similar way and just compares different alternatives one can get very useful results from a simulation experiment.

The results from a simulation experiment with the model are:

- per cent inbreeding
- progress in litter size, pelt quality, and body weight
- a simple graph for the progress in standard deviation units.

Parts of the output from an experiment with the parameters from figure 1 are shown in figures 2 and 3. The inbreeding is calculated for the 5 replicates from year 1 to 10 and the average for all replicates. Only year 1, 5, and 10 are shown in figure 2. The average inbreeding for the 5 replicates in 10 years is 10.3 percent.

The selection responses for litter size, pelt quality, and body weight are printed for year 1 to 10. The average for all replicates and the lowest and highest responding lines are listed for all three traits. Only the years 1, 5, and 10 are shown in figure 3.

### Simulation as a planning tool

The model has been used in an actual planning situation in the grading and selection season November 1995. A breeder had a wild mink line with a litter size of 7.13 kits per female and a reasonably good pelt quality.

His breeding goals are

- 1) maintain the litter size at its high level
- 2) a moderate improvement in pelt quality
- 3) as much improvement in body weight (to improve pelt size) as allowed by 1) and 2).

The problem was to find how much economic weight could be given to body weight and still allow improvements in quality and no change in litter size.

Year	Litter siz.			Pelt quality			Body weight		
	Aver.	Min	Max	Aver.	Min	Max	Aver.	Min	Max
1	-0.2	-0.4	0.1	0.3	0.2	0.4	47.7	1.6	81.3
5	0.1	-0.1	0.3	1.2	1.1	1.5	171.9	106.9	280.6
10	0.4	-0.0	0.6	2.4	2.2	2.7	332.8	245.4	395.5

**Fig. 3.** Output from SCANSIM simulation program. Progress in the three traits under selection.

Economic weights			Average response in			Alternat. no
Litter.	Quality	Weight	Litter siz.	Quality	Weight	
5	60	35	0,1	2,4	105	1
10	50	40	0,1	2,1	160	2
10	40	50	0,1	1,6	240	3
10	30	60	0,0	0,9	315	4
10	20	70	0,0	0,3	340	5

Population parameters from the actual population in 1994 were used.

Line size (population) 87 males and 435 females, 2/3 first year females

**Fig. 4.** Simulation experiment with SCANSIM. Five replicates in five years.

The plan and the results from the simulation experiment can be seen in figure 4. Alternative 1 is his actual selection from the 1994 season and in alternatives 2 to 5 priority is shifted from pelt quality to body weight.

Alternative 3 was used in the 1995 selection because it could more than double the progress in

body weight and the 'cost' was only a reduction in progress for pelt quality of one third, and litter size was not affected at all.

At the present marked situation this is a much more profitable program than the original alternative 1.

### Polychlorinated biphenyls (PCBs) and reproduction disturbances

Walter Popp, Carola Vahrenholz, Rudolf Kraus, Klaus Norpoth

A review of the impact of chlorinated biphenyls (PCBs) on reproduction is presented. PCBs are able to pass the placenta; accumulation in offspring is mainly achieved by breast feeding. Disturbances of fertility and embryotoxicity were detected in animals; teratogenicity without maternal toxicity was only observed in mice. In animal experiments disturbances of fetal and postnatal development were detected as well as in human studies. Neurotoxicity was observed even at low-level exposures in monkeys, which are most comparable to humans because of the development of the same clinical symptoms. Technical PCBs which are dominating in occupational and environmental exposure until now must be judged as toxic for reproduction: dermal exposure (especially in accidents) should be considered as an important route of exposure beside inhalation. Work to list possible PCB exposure risks and to develop ways to reduce these risks are necessary now.

*Zbl. Hyg.* 193: 528-556, 1993. In *GERM.* 10 tables, 137 refs. Authors' abstract.

### The principal reproductive indices in chinchilla laniger

M. Puzder, J. Novikmec

For the investigated chinchilla population, body length was 250-260 mm, tail length 170-180 mm, and ear length 60 mm. Age at sexual maturity averaged 8 months (4-10). Longevity was up to 20 yr, with the max. reproductive performance at 9 yr. Oestrous cycle length was 28 days, with increased sexual activity from Nov. to May, peaking in Jan.-Feb. Anoestrus occurred in summer and early autumn. Oestrus duration was 3 days. Mating was of short duration, and occurred mostly at night. Females formed an oestrous or a vaginal plug from consolidated vaginal secretions, closing the uterus to prevent the discharge of deposited semen or another mating. The number of Graafian follicles was 4-16, and the annual young production 4-8.

Ejaculate volume was 0.01-0.02 ml, containing  $120 \times 10^6$  spermatozoa. There was no success with AI. Postpartum oestrus interval was 12-48 h, and the possible number of 3 pregnancies annually was limited, by the breeding methods used, to 5 litters in 2 yr. The most frequent litter size was 2 (range, 1-4). Pregnancy duration averaged 111 days, large litters being born 1-2 days earlier and singles 1-2 days later. Parturitions were normally clustered in Mar.-May and in Aug.-Sep. Implantation occurred within 3 days, and 30-day embryos were the size of a pea; no embryo growth was noted between 40 and 60 days of pregnancy. Pregnancy diagnosis by palpation was difficult, and was done mainly by weighing the dam. Parturition duration ranged from minutes to 2 h. The placenta was consumed immediately after birth. Males nested with the young but left after the postpartum mating. Birth weight was 30-50 g, and the young were born fully developed. Weaning was at 50-56 days of age. Body weight at 1 month was around 120 g.

*Veterinarstvi* 42 (7): 258-259, 1992 (5 pp. English translation). In *SLOV.* CAB-abstract.

### Reproductive effort in the arctic fox *Alopex lagopus*: a review

Karl Frajford

This paper reviews the available information and hypotheses about litter size and reproductive effort in the arctic fox *Alopex lagopus*, considering both free-living populations and Norwegian farm foxes.

The most important factor for reproductive success in free-living foxes is probably food, and there appear to be two different strategies of litter size.

In regions with voles and lemmings, the arctic fox has large litters but breeds only in years when the numbers of small rodents are high. In regions without small rodents, the arctic fox has small litters but may breed more regularly or annually. The litter size of farm foxes seems to be in-between that of the two groups of native foxes, perhaps resulting from the diverse origin of farm foxes. A reduction in the litter size of farm foxes during the period 1977-1992 was found, but most of this may indirectly have resulted from cross-

breeding with red foxes *Vulpes vulpes* which started about 1982. An increase in the proportion of breeding females and a reduced mortality of pups may be more profitable than an increase in the number of pups per female.

*Norwegian Journal of Agricultural Sciences* 7: 301-309, 1993. 2 tables, 1 fig., 38 refs. Author's summary.

#### **The endocrine function response of mink gonades to administration of chorionic gonadotropin under artificial light conditions**

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

Experimental regimens imitating early coming of autumn and stimulating the reproductive system of male and female mink revealed that, with additional illumination, responses of both male and female gonades after the chorionic gonadotropin administration in November, were argued.

*Sechenov Physiological Journal* 79, No. 4: 75-80, 1993. In RUSS, Su. ENGL. 2 tables, 2 figs., 20 refs. Authors' summary.

#### **Sex steroids and brain serotonin in silver foxes during the estrus cycle**

L.V. Osadchuk, N.N. Voitenko

A significant increase in hypothalamic serotonin and estradiol levels was found in silver foxes during proestrus. During estrus, the plasma estradiol concentration was reduced and a significant increase in progesterone level was correlated with a decrease in the brain serotonin content.

The data obtained suggest that the brain serotonin plays a mediating role in the control of ovarian hormonal activity and ovulation in silver foxes.

*Sechenov Physiological Journal* 78, No. 4: 118-123, 1993. In RUSS, Su. ENGL. 2 tables, 20 refs. Authors' summary.

#### **Whelping performance in 1993**

Kaj Eklund

In 1993, in Finland, litter size at birth per breeding female averaged 4.12 for mink, 5.99 for polecats, 5.66 for blue foxes, 4.74 for blue fox females mated with silver fox males, 2.82 for silver foxes, and 5.66 for raccoon dogs. The results are compared with those in the previous 2 years.

*Finsk Pälstidskrift* 23, 8-9: 184, 1993. In SWED, 1 table. CAB-abstract.

#### **Blood barriers of the epididymis and vas deferens act asynchronously with the blood barrier of the testis in the mink (*Mustela vison*)**

R.-Marc Pelletier

The purpose of the present study was to determine whether the blood barrier of the epididymis and vas deferens acted synchronously or not with the blood barrier of the testis. The permeability of the blood-epididymis and blood-vas deferens barrier was tested in neonatal mink kits up to puberty and monthly in adult mink throughout the annual seasonal reproductive cycle. Attention was focused particularly on time intervals when the blood barrier of the testis has been documented to be permeable, namely, before puberty and during testicular regression in the adult. One of two electron-opaque permeability tracers was perfused into the blood stream: horseradish peroxidase (HRP) or lanthanum nitrate. The convoluted tube of the epididymis was divided into three anatomical regions: the caput, corpus, and cauda. The vas deferens was divided into proximal and distal regions. At birth and throughout puberty, the three regions of the epididymis and the two of the vas deferens showed a lumen and a competent blood barrier. In the adult, a lumen persisted in the epididymis and vas deferens throughout the annual seasonal reproductive cycle, and the blood barrier of the excurrent duct remained impermeable even when the blood barrier in the testis became momentarily permeable during testicular regression. When HRP was used

to test the permeability of the blood-tissue barrier of the excurrent ducts, no tracer deposits were observed on the luminal surface of the epithelium. Conversely, when lanthanum served as the tracer, deposits of the probe were associated with microvilli and intracellular membranes despite impermeability of tight junctions. The data show that the lanthanum technique can yield false-positive results. The findings also indicate that 1) a blood-excurrent duct barrier is established before the blood-testis barrier and 2) the two barriers act asynchronously. It is therefore plausible that they are modulated by distinct factors.

*Microscopy Research and Technique* 27, pp 333-349, 1994. 20 figs., 42 refs. Authors' summary.

#### **Synaptonemal complex analysis of spermatocytes in hybrids of silver fox and blue fox**

*I. Gustavsson, M. Switonski, K. Larsson, L. Plöen*

Investigations of male meiosis in silver fox x blue fox hybrids have revealed meiotic arrest at the first prophase stage. Synaptonemal complex analysis using light and electron microscopy demonstrated the occurrence of multivalents, bivalentlike structures, and unpaired axes. We conclude that the sterility of male hybrid foxes probably is due to pairing problems of chromosomes caused by extensive karyotypical differences of the two species, resulting in unpaired chromosomes, chromosome segments, and broken chromosomes.

*Journal of Heredity* 79, pp 338-343, 1988. 4 figs., 1 table, 33 refs. Authors' abstract.

#### **Circadian variations in plasma levels of sexual and corticosteroid hormones in silver fox**

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

Selection of silver fox for domestic behaviour leads to a lot of changes in hormonal regulation of adaptation and reproduction. It was suggested that selection can change the circadian system. The aim of the present work was to investigate circadian variations in plasma level of oestradiol, testosterone

and cortisol in silver foxes in control and domesticated populations.

We have observed diurnal rhythm in plasma concentrations of cortisol. Cortisol levels elevated during the morning hours (10.00) in silver foxes in the control population and fell to a nadir between 14.00 and 22.00 h and then slightly increased again at night (2.00). The domesticated animals have another diurnal pattern of cortisol which is only characterized by decreasing cortisol levels at night (22.00-2.00 h).

No considerable fluctuations were observed for sexual hormone concentrations over the 24-h blood sampling period.

The obtained results indicate that selection of foxes for domestic behaviour modifies the diurnal rhythm of plasma corticosteroid levels. It is possible that the observed changes in plasma cortisol rhythm resulted from an altered circadian pattern in central regulatory systems controlling corticosteroid adrenal function.

*Congrès du G.E.R.B. 1993, ISSN 0154-0238. Only abstract received. Authors' abstract.*

#### **Freeze-fracture study of cell junctions in the epididymis and vas deferens of a seasonal breeder: the mink (*Mustela vison*)**

*R.-Marc Pelletier*

The present study used the freeze-fracture technique and vascular infusion of horseradish peroxidase (HRP) as a junction permeability tracer, visible in thin sections, to investigate potential seasonal variations in the mink epididymis and vas deferens cell junctions. The junctions were studied in kits during the neonatal period, during and after puberty, and during adulthood monthly throughout the annual reproductive cycle. Results showed the existence, at the time of birth, of a junctional complex joining ductal cells that reached the lumen of the epididymis and vas deferens. The luminal impermeable segment of the junctional complex was characterized by the presence of an occluding zonule made up to continuous tight junctional

ridges extending around the perimeter of the cell. The basal permeable segment of the junctional complex contained mainly discontinuous ridges frequently forming gaps and tight junctions next to adhering junctions. Receding annular junctions were present in the apical and lateral cytoplasm of principal and clear cells. The membrane domain apical to the occluding zonule bore 30-35 nm exo/endocytosis blebs and 40-60 crenations associated with deforming tight and gap junctions made up of randomly scattered particles. Patterns of junctional strands varied greatly from one principal and/or clear cell to another. However, cell junctions did not significantly vary from the neonatal period to adulthood nor from breeding to testicular regression.

Anatomical subdivisions of the epididymis with fewer junctional strands per zonule and high diversity in their patterns exhibit no permeability differences to HRP when compared with subdivisions

containing more numerous strands. The junctions were impermeable during the neonatal period and throughout the annual reproductive cycle. The following conclusions were reached:

1) a competent occluding zonule developed in the mink epididymis and vas deferens before it did in the testis; 2) the number of strands and the diversity of patterns did not correlate with permeability differences; 3) after the development of a lumen in the testicular excurrent duct, neither receding cellular changes caused by testicular regression nor seasonal passage of a bolus of sperm through the duct modified the occluding zonules; and 4) in the testicular excurrent duct, junction modulation (i.e., formation and deformation) paralleled that in the testis and followed the direction of the synthesis-transport-secretion process.

*Microscopy Research and Technique* 30, pp 37-53, 1995. 24 figs., 49 refs. Authors' summary.

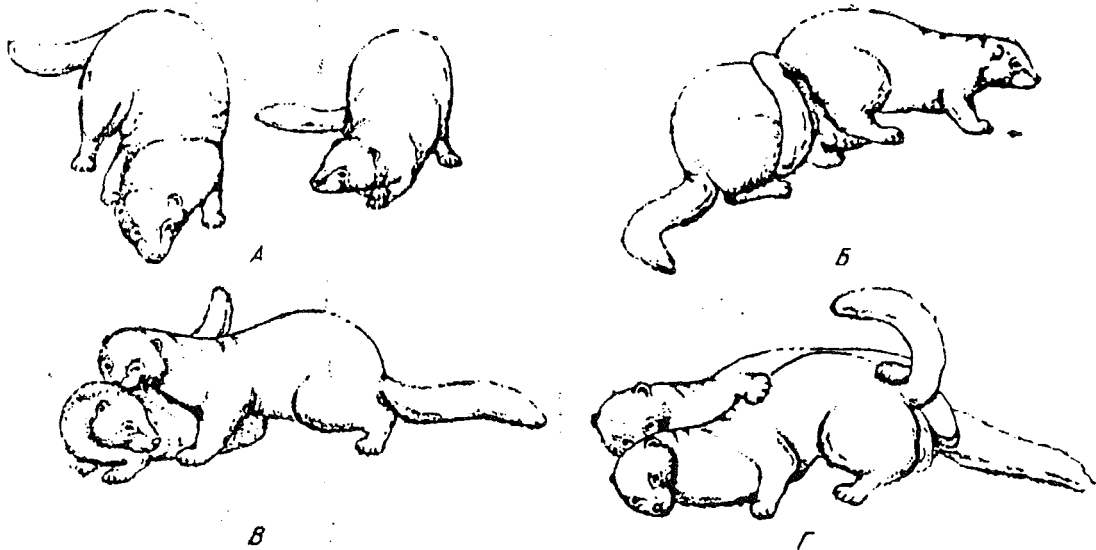


Рис. 1. Элементы сексуального поведения американской норки  
 А, Б — приближение самца к самке; В, Г — удержание самцом самки за кожу  
 шейной области

Рис. 2. Характерная манера держаться у доминирующего животного





*Original Report*

## **Succinic acid as a stimulator of physiological processes and productivity in farm mink**

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### **Abstract**

It has been said that succinic acid (SA) added to the rations of cage - bred mink stimulates the physiological condition and productivity of them. SA has an improving effect on the energetic metabolism of weakened kits and lactating females. This preparation normalizes blood enzyme activity, increases the aerobic fraction of LDH and stimulates the growth and development of the animals. Adding SA to the diets of healthy juvenile mink improves the commercial indices - size of skins and their quality. The effect of SA on the hypothyroid kits is stronger than on healthy fur animals.

### **Introduction**

It is known that succinic acid (SA) is a biologically active preparation, a natural metabolite. A special interest in SA is connected to its intensifying restorative processes in a biochemical and physiological

sense, which is based on an extremely high activity of this preparation. SA, as a component of the energy metabolism, has a principal role in the regulation of physiological functions, which provides the resistance of an organism to extreme environmental factors and different pathologies.

All this gives grounds for using SA in fur farming where the animals are affected by multiple environmental factors including stress causing loss in productive qualities.

Employing SA in fur farming is an urgent problem, since it aims at the solving the main problem - optimizing the physiological condition and increasing the productive qualities of the animals.

The present work is directed at generalizing the results of the prolonged research of the effect of SA on the physiological condition, growth, development and fur quality of cage-bred mink.

## Materials and methods

Studies have been made on dark-brown mink bred on Karelian farms. The succinic acid obtained from furfurool (Specification TY-6-09-40-3237-87, 1988, p.16) was added to the food rations. Succinic acid is an ecologically pure product of natural origin, a substrate of oxidation participating in the Krebs cycle in all live animal and plant organisms. The mass fraction of SA is 97.5% in the preparation, and 2.5% fumaric acid, also a natural metabolite. SA was added to the food at a dose of 50 mg/kg mink body weight. The frequency and scheme of administration are the property of the author of this article and are patented for use in fur farming. Address for consultations and buying licenses for using SA: 185610, Petrozavodsk, 11 Pushkinskaya str., Karelia, Russia.

The effect of SA was studied on weakened (conventionally called hypotrophic) mink kits and adult healthy cage-bred mink. The serum enzyme activities of lactate dehydrogenase (LDH, EC 1.1.1.27), aspartate aminotransferase (ASAT; EC 2.6.1.1.), alanine aminotransferase (ALAT; EC 2.6.1.2.), alkaline phosphatase (AP; EC 3.1.3.1.) were determined by the microexpress method (Berezhov, 1981). Multiple molecular lactate dehydrogenase forms in blood serum and liver extracts were revealed by agar gel electrophoresis (Berezhov, Kozhevnikova, 1981; Meldo et al., 1987).

The animals were weighed monthly. After slaughtering, the fur quality and the skin size were assessed. The mink kept on general rations were the control animals.

## Results and discussion

Knowing the properties of SA as a stimulator of the functions most markedly manifested in a weakened organism, first of all we have tested the preparation on the weakened (conventionally called hypotrophic) mink kits and adult mink females at the reproduction stage. The enzymatic status of mink blood and the changes in the body weight of the animals were controlled.

The results showed that the activity of the blood enzymes - LDH, AP, ASAT - in hypotrophic mink was higher than in the control animals (fig. 1).

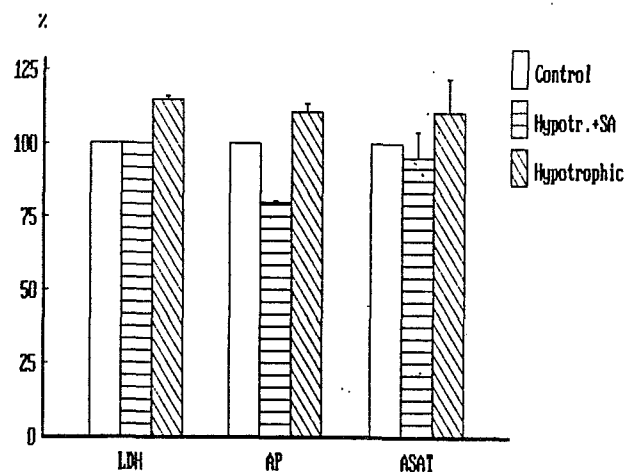


Fig. 1. The influence of succinic acid (SA) on blood enzyme activity in 5 month old hypotrophic mink kits.

Adding SA to the kits' food caused the normalization of the activities of LDH and ASAT. The activity of LDH in the blood of hypotrophic kits fed the rations including SA corresponded to that in the control mink, since this preparation prevented an increase in the total activity of LDH observed at an earlier age (Kozhevnikova et al., 1991). A high background activity of ASAT in hypotrophic kits is normalized only in October. Under the influence of SA the AP activity decreased, and its reduction below the level observed in the control animals was compensated by increase of AP in the leukocyte which was extremely low in the hypotrophic kits (Uzenbaeva, Meldo, 1991).

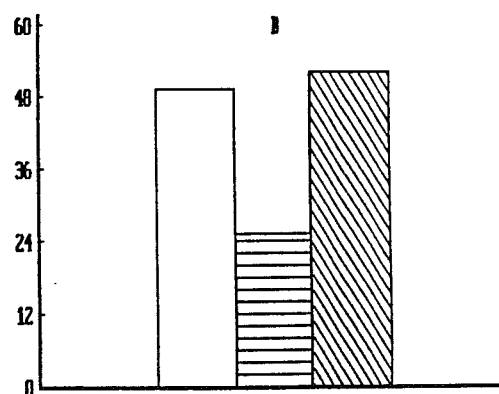
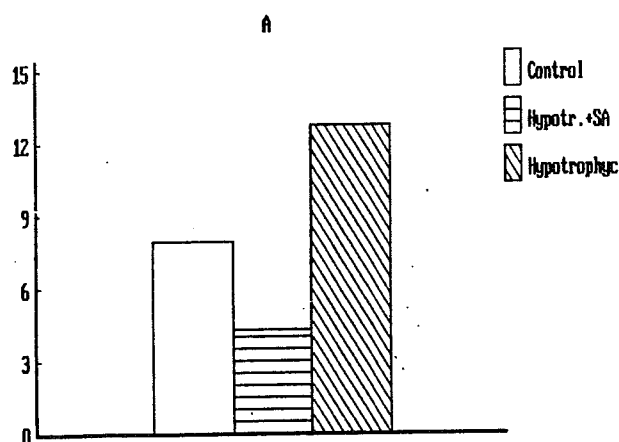
It is evident from the table that in hypotrophic kits as well as in healthy, the serum LDH was represented by five molecular forms. The relation of isoenzymes corresponded to the earlier observed species specificity in the distribution of isoenzymes in mink blood serum, when a relative content of the anode form of LDH-1 and LDH-2 was markedly lower than LDH-5 (Kozhevnikova, 1989).

In hypotrophic kits the relative content of LDH-5 was higher, and the sum of the anode forms (LDH-1 + LDH-2) lower than in control animals. This phenomenon had a reflection in the anaerobiosis index (ratio activity of LDH-5/LDH-1) which was naturally higher in the weakened kits (12.83) than in control (7.92).

**Table 1.** Effect of succinic acid on the isoenzymatic spectrum of LDH in blood serum and liver extracts of hypotrophic kits of dark brown mink

Indices	Group		
	Hypotrophic		Normal
	1 without SA	2 with SA added	3 control
	M ± m	M ± m	M ± m
Blood serum			
LDH-1	4.62±1.1	11.00±2.5	5.95±0.8
LDH-2	7.39±0.8	11.85±3.1	11.76±2.3
LDH-3	22.11±3.4	25.08±2.3	26.6±4.6
LDH-4	6.72±0.6	4.74±0.6	8.54±2.8
LDH-5	59.16±4.6	47.30±3.1	47.12±6.6
LDH-5/LDH-1	12.83±1.2	4.3±0.4	7.92±0.7
Liver			
LDH-1	1.73±0.2	2.66±0.3	1.54±0.1
LDH-2	2.66±0.2	4.85±0.5	3.39±0.3
LDH-3	5.03±0.4	9.39±1.1	6.97±1.3
LDH-4	4.85±0.5	6.33±0.1	7.04±0.6
LDH-5	85.70±7.6	76.72±11.2	81.04±7.2
LDH-5/LDH-1	49.50±4.8	28.84±2.6	52.50±4.9

Adding SA to the rations of hypotrophic kits caused an increase in the relative content of LDH-1 and LDH-2 (22.8%) and a fall in the anaerobiosis coefficient by nearly 3-fold (fig. 2A) testifying to the stimulation of the aerobic glycolysis paths.

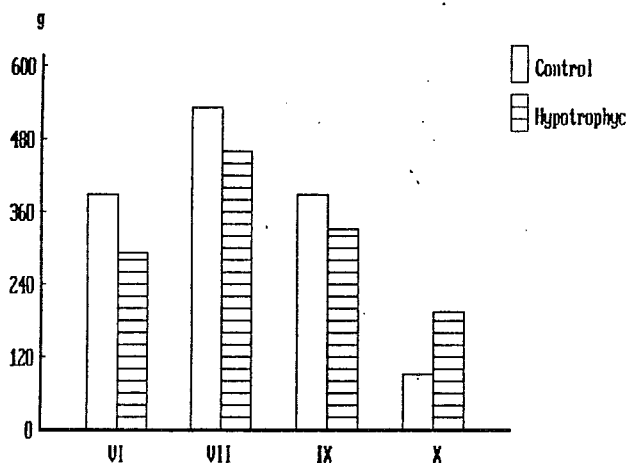


**Fig. 2.** The influence of succinic acid on the coefficient LDH-5/LDH-1 in blood serum (A) and liver (B) of mink kits.

The shift of the lactate dehydrogenase reaction towards the aerobic process under the influence of SA was observed on the organ level, particularly in the liver (Table 1). It appeared that, in hypotrophic kits under the effect of SA, the ratio LDH-5/LDH-

1 was reduced nearly twice (fig. 2B) at a high relative content of LDH-5 which is specific to this organ (Kozhevnikova, 1989). Moreover, this decrease in the coefficient of anaerobiosis was significant not only in regard to diseased animals but also healthy (control), which is proof of an intensive stimulation of the aerobic ways of glycolysis by SA.

Thus, the effect of SA is well-pronounced in hypotrophic mink kits. It normalizes the enzymatic activity of blood. Succinate prevents the increase of total LDH activity in weakened animals by stimulating the aerobic ways of glycolysis. An increase in the relative content of the anode fractions of LDH, showing up not only on the level of serum but also in liver extracts and following a decrease of the relative content of the LDH-5 fraction, is proof of the activated energetic metabolism by SA. A simultaneously increased activity of ASAT observed in addition to the reported change in the isoenzymatic spectrum of LDH indicates the role of the aspartate aminotransferase reaction in the total chain of energetic metabolism.



**Fig. 3.** The influence of succinic acid on the absolute monthly growth of body weight in hypotrophic and control mink kits.

The stimulation of energetics by SA revealed by us in blood serum and liver is reflected on the level of the whole organism, in particular, on the intensity of the growth of hypotrophic kits. The weakened animals affected by SA gradually gained body weight despite the fact that the initial body weight in the hypotrophic kits was one-third lower than the control (fig. 3). As a result, their absolute

weight increment in October increased by 60% compared with the weight increment in healthy kits, which favoured the levelling of the total weight increment in the weakened and healthy animals.

Similar regularities in the change of body weight in mink were revealed in a number of experiments in which we tested a possibility of the regulation of the physiological condition of adult mink females by adding SA to their rations from the second half of pregnancy. From Table 2 it follows that the test and control females had in October practically equal body weights despite a certain difference in the initial ones (February). The body weight of the test females grew at the expense of the everyday increments under the effect of SA, already beginning with the period of intensive lactation (the weight increment in early June was highest). In October the final weight increment exceeded the one in the control animals by 25%. The improved physiological condition of the adult females assessed by the weight increments was obviously a result of the effect of SA on the ways of energy metabolism. For instance, in the lactation period the total activity of LDH in mink females under the effect of SA was reduced by 50% compared to the level in the control animals. Precisely at this time, when the functions connected with lactation were intensified, the efficiency of SA was the highest and compared with other biological periods led to the maximum aerobization of the LDH isoenzymatic spectrum of LDH (ratio LDH-5/LDH-1 was the lowest), showing an important role of aerobic glycolysis while strengthening the functions of the maternal organism. In lactating females as well as in hypotrophic kits, in addition to the aerobization of the isoenzymatic LDH spectrum an increase of the total activity of this enzyme took place under the influence of SA, and the increase of ASAT activity was attended by a sustained ALAT background and a decrease in AP activity. The regulatory effect of SA on the physiological condition of the hypotrophic kits and lactating adult females is an example of a possible control of the functional condition of animals. For example, earlier it has been shown that at lactational exhaustion of mink females the energy exchange is inhibited, and only by affecting its level directly is it possible to stabilize the animals' condition (Bereztov, Kozhevnikova, 1981). I.e. an effect at the

energy level regulates the functional condition of the organism on the whole.

The above-reported normalizing effect of SA on the mink organism can cause an increase in the productive qualities of the animals and, first of all, improvement of mink fur quality (Patent).

**Table 2.** Body weight dynamics of adult dark brown female mink fed rations added SA

Month	Test	Control
	M ± m	M ± m
February	972±52.4	1040±55.5
March	896±27.8	915±58.5
June	938±72.0	822±77.0
July	1040±41.6	948±46.4
August	1126±35.7	1045±30.4
September	1152±61.7	1040±38.3
October	1388±39.3	1350±85.6
Total weight increment	416±39.0	310±55.2

Adding SA to the rations of the adult females during pregnancy and lactation has a positive effect not only on the monthly body weight increments, as has been shown above, but also on the useful qualities of the juveniles. The analysis of the data indicates that under the effect of SA the total weight increment of the juveniles (females and males) increased on average by 10% compared to the control (Table 3). The commercial quality of the skins improved (Table 4). The size of female skins grew by 8% and male by 5%. The number of large female skins increased by 23.4%, especially large male skins by 26.9% compared with the control. The quality of test female skins grew markedly. The number of normal (no defects) skins increased by 23% and the number of the skins with medium defects decreased by 12%. As a result, the quality in the female test group exceeded the control by 10%, male by 7%. Thus, adding SA into the rations of the adult females during pregnancy and lactation has a positive effect on the kits produced by them, i.e. an improvement of the juveniles' physiological condition via the mothers' organism takes place.

**Table 3.** Body weight dynamics of mink kits (female + males) produced by mothers fed rations with added SA

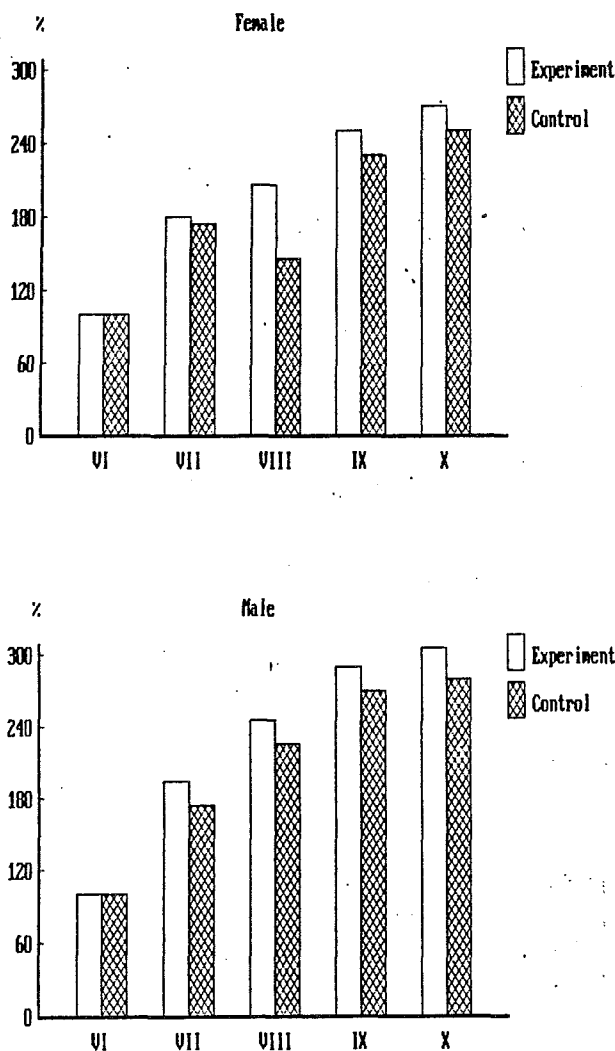
Month	Test	Control
	M ± m	M ± m
June	536±29.5	525±34.8
July	792±53.5	746±60.9
August	1213±73.2	1083±76.7
September	1616±141.1	1457±118.6
October	2171±205.2	2005±159.4
Total weight increment	1636±117.3	1480±115.0

**Table 4.** Quality assessment of skins of kits produced by mothers fed rations with added SA

Indices	Test (50 mg/kg)	Control
	% of the total number of skins	
<b>FEMALES</b>	n=24	n=19
Size:		
Large	70.8	47.4
Medium	29.2	52.6
Defect:		
Normal	33.3	10.5
Small	39.3	42.1
Medium	25.0	36.9
Large	2.4	10.5
Area of skins, cm <sup>2</sup>	754.9	699.0
% of control	108.0	100.0
% of standard quality skins	81.0	71.0
<b>MALES</b>	n=13	n=14
Size:		
Especially large A	15.4	21.4
Especially large B	76.9	50.0
Large	7.7	28.6
Defect:		
Normal	30.8	28.6
Small	23.1	14.3
Medium	38.5	42.9
Large	-	7.1
Rejects	7.6	7.1
Area of skins, cm <sup>2</sup>	1061.7	1011.3
% of control	105.0	100.0
% of standard quality skins	101.9	94.1

Taking into account the efficiency of SA, we have organized its testing on a number of Karelian fur farms ("Kondopozhsky zverovod", "Sviatozersky" fur farm, etc.) which confirmed its very useful properties.

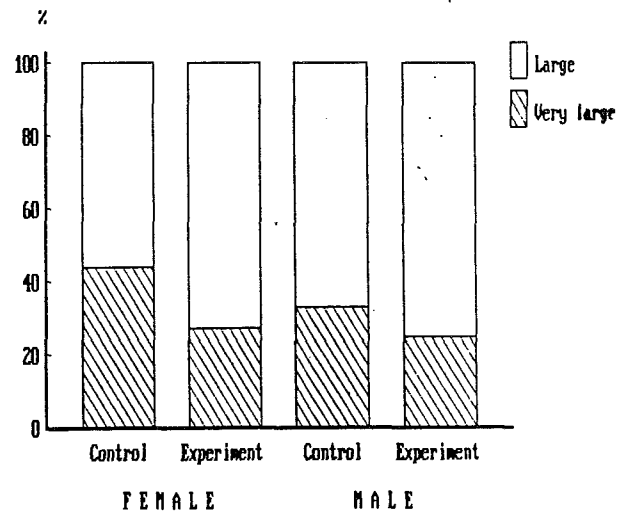
Special SA testing in fur farming has shown that, in clinically healthy mink kits, this feed additive produced a positive effect on the accumulation of live mass in females and males (fig. 4).



**Fig. 4.** The influence of succinic acid on the relative monthly body weight increment (% of the initial level) in female and male mink in industrial experiments.



Moreover, in the test females at the age of 4 months there was no slow down in the increment of live mass which was observed in the control animals. The effect of SA has also manifested itself on the commercial characteristics of the skins, which is shown in the diagram (fig. 5). One can see that the skin size in the test mink was larger. In the females the percentage of large skins exceeded the one in the control ones. In males, especially large skins prevailed at the expense of a decrease in the number of large, all of them had less defects which determined a higher percentage of high-quality skins.



**Fig. 5.** The influence of succinic acid on the quantitative distribution of mink skins (female and male) of different sizes, in %.

Thus, the testing has shown that employing SA in fur farming allows a normalization of the functions of mink as well as improvement to its productivity.

Succinic acid obtained from furfural is comparatively cheaply produced on a commercial level. Since it is a natural metabolite, it is not accumulated in the organism of fur animals which excludes side effects.

The preparation is efficient in small doses, and the administration technique is simple, which makes it accessible for wide use on fur farms.

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### Utilization of iron by foxes given feed with added Livex

S. Jarosz, B. Barabasz, O. Szeleszczuk, B. Gawlikowska

The authors investigated the effect of Livex in the feeding of polar foxes (as it contained an increased amount of easily available iron) and its effect on iron metabolism. The investigations were made on the Fox Farm of State Farm Gliwice, between July and December 1988. The experimental animals were divided into three groups (30 animals each): group I - feed with 50% Livex added; group II - feed with 50% Livex added + CuSO<sub>4</sub> (10 mg per kg of fresh feed); group III - Control, farm feed, no Livex added.

The animals of group I showed a final body mass lower (7.03 kg) than those in group III fed no Livex (7.58 kg). As to live body length the animals of all groups did not differ significantly (59.5 - 60.9 cm).

The estimation of some features of the hair cover (colour purity, length, elasticity, and silkiness of hairs, all-over estimate) was most advantageous in group III (controls) while the differences between the latter and groups I and II were significant. The surmised negative effect of large additions of Livex (50%) to the feed was corroborated as to colour purity and structure of hair cover. Colorimetric measurements of colour purity of the hairs corroborated this suggestion. Healthiness of the control animals and those fed large doses of Livex did not deteriorate, as the animals grew correctly, were fit, and no deaths were noted among them. Also, no great changes were noted in the haematological indices or in enzymatic activity of transaminases ALAt and AspAt. An analysis of contents of iron and copper in blood serum showed their highest level in foxes of group II. Iron in considerable amounts was also found in hairs of animals of groups I and II. The relation between Fe and Cu necessitates further investigations.

Zeszyty Naukowe Akademii Rolniczej w Krakowie, Zootechnika 27, 242: 135-154, 1991. In POLH, Su. ENGL, RUSS. 8 tables, 13 refs. Authors' summary.

### Dietary variation in Arctic foxes (*Alopex lagopus*) - an analysis of stable carbon isotopes

A. Angerbjörn, P. Hersteinsson, K. Lidén, E. Nelson

We used stable carbon isotopes to analyse individual variation in Arctic fox diets. We extracted collagen from bones (the lower jaw), and measured stable carbon isotopes. The foxes came from three different localities: Iceland, where both microtines and reindeer are rare; west Greenland, where microtines are absent; and Sweden, where scat analyses showed the primary food to be microtine rodents and reindeer. The Icelandic samples included foxes from both coastal and inland habitats, the Swedish sample came from an inland area, and the Greenland sample from coastal sites. The spatial variation in the isotopic pattern followed a basic division between marine and terrestrial sources of protein. Arctic foxes from inland sites had  $\delta^{13}\text{C}$  values of -21.4 (Iceland) and -20.4‰ (Sweden), showing typical terrestrial values. Coastal foxes from Greenland had typical marine values of -14.9‰, whereas coastal foxes from Iceland had intermediate values of -17.7‰. However, there was individual variation within each sample, probably caused by habitat heterogeneity and territoriality among foxes. The variation on a larger scale was related to the availability of different food items. These results were in accordance with other dietary analyses based on scat analyses. This is the first time that stable isotopes have been used to reveal individual dietary patterns. Our study also indicated that isotopic values can be used on a global scale.

*Oecologia*, 99: 226-232, 1994. 2 tables, 5 figs., 45 refs. Authors' abstract.

### Food habits of Arctic foxes (*Alopex lagopus*) on the Western coast of Svalbard

Karl Frajford

Food habits of Arctic foxes (*Alopex lagopus*) on the western coast of Svalbard were studied in the years 1986-89. Faeces (n=1018) were collected



mostly in summer, and food remains were recorded both at dens and elsewhere in the region. The foxes were opportunistic in their hunting and feeding habits, utilizing a wide variety of available food items. Alcids (mainly little auks and Brünnich's guillemot), gulls (mainly kittiwakes), and fulmars were the major foods in summer. The consumption of alcids by fox families was collected with availability near the den. In winter, fulmars and, in one region, seals were important foods. Some regional differences in food consumption were found. A change in diet was observed when a litter of pups moved from one den to another (2 of 3 cases). Differences in food habits between years were also found at the same den (4 of 5 cases). Foxes frequently cached food by scatter hoarding, placing only a single item in each cache.

*Arctic, Vol. 46, No. 1: 49-54, 1993. 4 tables, 3 figs., 24 refs. Author's abstract.*

### The disposition of some metals in mammals and fish: effects of lipophilic chelation

Kathleen Borg-Neczak

Dithiocarbamates, thiuram sulphides, xanthates, dialkyldithiophosphates, pyridinethiones and 8-hydroxy- and 8-mercaptoquinolines are groups of compounds which can form lipophilic complexes with metals. These compounds are widely used as pesticides, as drugs and in industry. In the present study mice, rats, guinea-pigs and ferrets were given substances belonging to these groups of compounds together with nickel (as  $^{63}\text{Ni}^{2+}$ ) and the uptake and distribution of the metal in the animals were then examined. Brown trouts were also exposed to these groups of compounds together with inorganic mercury (as  $^{203}\text{Hg}^{2+}$ ) and the uptake and distribution of this metal by the fish were then studied.

The experiments with nickel showed that some of the complexing substances caused highly increased tissue levels of the metal in the animals. However, the enhancing effect varied with different compounds. A facilitated penetration of the lipophilic nickel-complexes across cellular membranes may underlie the increments in the tissue levels of the

metal, but the effects on the disposition of the nickel may vary depending on the lipophilicity and the stability of the complexes.

Most of the complexing substances induced increased tissue levels of mercury in the trouts, although the effects were generally less marked than for the nickel.

Studies in brown trouts exposed to inorganic mercury without presence of the chelating substances showed an avid uptake from the water and a highly differentiated localization to specific tissues. An accumulation of the metal was found in the olfactory system. Studies in pikes showed that mercury is taken up in the olfactory receptor cells in the olfactory mucosa and is transported along the olfactory axons to the olfactory bulbs of the brain. Manganese was also shown to be taken up in the olfactory system of the pike. In contrast to mercury, manganese was able to pass the synaptic junctions between the primary and secondary olfactory neurons in the bulb. The manganese can then move along secondary olfactory neurons into the telencephalon.

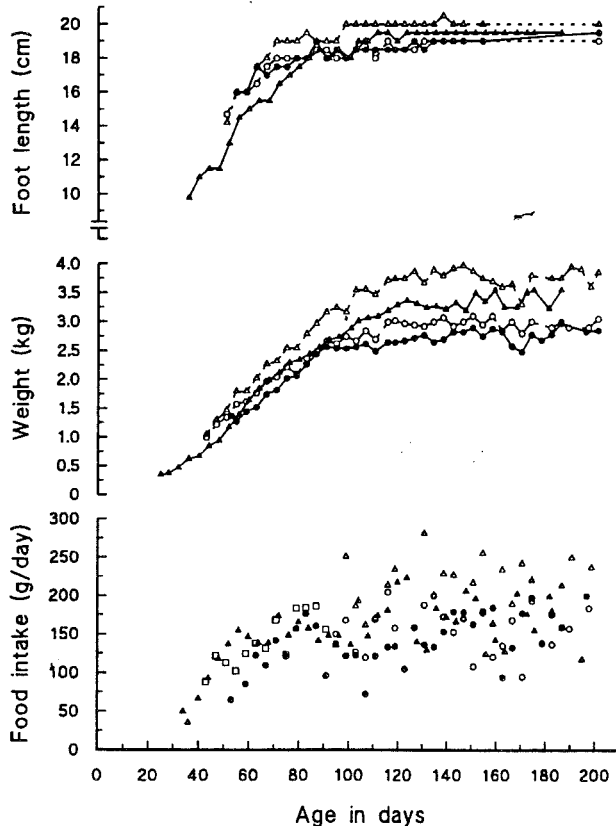
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*Thesis, 45 pp. 72 refs. Author's abstract.*

### Growth rates and energy demands in captive juvenile Arctic foxes *Alopex lagopus* in Svalbard

Karl Frajford



**Fig. 1.** Growth in foot length, changes in weight, and food intake (g dry weight/day) by age in four captive arctic foxes. all foxes: food intake =  $20.7 \cdot \text{Age}^{0.42}$ ,  $r^2=0.33$ ,  $F_{1,122}=66.4$ ,  $P<0.001$ .  $\blacktriangle$  Dick  $\sigma$ ,  $\triangle$  Rakke  $\sigma$ ,  $\circ$  Arnica  $\text{♀}$ ,  $\bullet$  Ossi  $\text{♀}$ ,  $\square$  Rakke  $\sigma$  + Arnica  $\text{♀}$

Four Arctic fox *Alopex lagopus* pups (two males and two females) were caught at dens when about 25-53 days old and kept in outdoor pens at Ny-Ålesund, Svalbard. Their growth in body size (as measured by the length of a front foot), increase in weight, and food consumption were monitored from July to December, 1987. The pups grew rapidly and reached  $97.5 \pm 0.1\%$  of their maximum adult size when they were 99-127 days old. Increase in body weight took longer (130 days). Food consumption generally increased until about 90 days old, after which it was highly variable. Pups consumed on average  $266 \text{ kcal kg}^{-1}$  growing  $34 \text{ g/day}$  until 95 days old. Subsequently, until

about 200 days old, they consumed  $202 \text{ kcal kg}^{-1} \text{ day}^{-1}$  and grew  $6.8 \text{ g/day}$ .

*Polar Biol* 14: 355-358, 1994. 1 table, 3 figs., 10 refs. Author's abstract.

### The 10 most common errors in mink dietary formulations - '92-93

William L. Leoschke

The only hope for the survival of the North American mink industry is for ranchers to work with nutritional programs that allow the economical production of the highest quality mink pelts raised on the planet earth. I do hope that the insights provided in this essay may be benefit ranchers throughout the continent and enable them to meet the goal of "top performance of the mink in all phases of the ranch year in combination with minimum feed costs per pelt marketed".

*Blue Book of Fur Farming*, pp. 23-33, 1994. 2 tables. Author's summary.

### Determination of concentrations of some mineral substances in the organs of fox

D. Mertin, E. Oravcová, P. Sviatko, K. Süvegová

In the present paper concentrations of cobalt, copper, manganese, zinc, calcium, magnesium, potassium, sodium, iron, cadmium and lead were investigated in liver (*hepar*), stomach (*ventriculus*), and in striated muscle (*musculus biceps femoralis*) of 30 females and 30 males of silver fox (*Vulpes vulpes*) and 30 males and 30 females of Arctic fox (*Alopex lagopus*). The animals were kept on a fox farm of the Division of Fur Animals in the Research Institute of Animal Production at Nitra.

They were healthy, with optimum fitness, on full-value diet. The organs were taken after skinning in fur maturity. Concentrations of mineral elements in the organs were determined by atomic absorption spectrophotometry. The results are presented in form of basic variation-statistical data; significance of differences in arithmetical means was calculated by *t*-test.

Significant differences between the males and females of silver fox were found in mineral element concentrations in some organs.

The males had statistically significantly higher ( $P \leq 0.01$ ) concentrations of Co and Zn in muscle, of Cu in liver and stomach, Mn in liver, Mg, K and Na in liver, stomach and muscle, Pb in liver and muscle. The females had significantly higher concentrations of Mn, Cd, Pb in stomach, Ca in stomach and muscle, Fe in liver and stomach.

In absolute values, the highest K concentration was determined in all investigated organs of silver fox, both in the males (12,500.60 - 5,096.77 mg/kg) and in the females (10,419.90 - 3,490.30 mg/kg). On the contrary, cadmium content was lowest of all (0.27 - 0.17 mg/kg and 0.37 - 0.17 mg/kg, respectively).

Arctic foxes also exhibited significant differences in concentrations of some mineral elements in certain organs between the males and females. The males had significantly higher values ( $P \leq 0.05$ ) of Mn and Fe in stomach and muscle, of Ca, Mg in stomach and liver, Cd in stomach and Pb in muscle in comparison with the females. The females had higher concentrations of Cu and Zn in stomach, liver and muscle, K and Na in stomach and Fe and Pb in liver.

Like in silver foxes, in Arctic foxes the highest concentrations were determined in K in the males (9,397.63 - 3,575.30 mg/kg) and also in the females (9,572.17 - 5,655.90 mg/kg). The lowest content of all in the investigated organs of Arctic foxes was found in cadmium (0.47 - 0.17 mg/kg and 0.20 - 0.17 mg/kg, respectively).

Besides the comparison of mineral element concentrations between the males and females within the species, significance of differences in arithmetical means of mineral concentrations between the silver fox and Arctic fox was tested within the sex.

In a majority of the investigated mineral elements, significant differences in the content of mineral substances in liver were determined between the males of silver fox and Arctic fox. Significantly higher ( $P \leq 0.01$ ) concentrations of Co, Cu, Zn and

Na were determined in silver fox males while the concentrations of Mn, Mg, K, Fe were significantly higher ( $P \leq 0.01$ ) in the liver of Arctic fox males. Similarly, significant differences were found in the females: silver foxes had higher Co and Ca contents at a significance level  $P \leq 0.01$  while Arctic foxes had higher concentrations of Cu, Mn, Mg, K, Fe, Pb ( $P \leq 0.01$ ) and Na ( $P \leq 0.05$ ).

A comparison of concentrations of particular elements in stomach in silver fox males and Arctic fox males showed significant differences in all the investigated elements. Silver fox males had significantly higher contents of Co, Cu, Zn, K, Na ( $P \leq 0.01$ ) and Mg ( $P \leq 0.05$ ) compared with Arctic fox males. Silver fox females had higher concentrations of Ca, Na, Fe, Cd, Pb ( $P \leq 0.01$ ) and Mg, K ( $P \leq 0.05$ ) while the content of Cu was higher in Arctic fox females ( $P \leq 0.01$ ).

Silver fox males had significantly higher contents of Mg, K, Fe and Pb ( $P \leq 0.01$ ) in striated muscle in comparison with Arctic fox males which had higher concentrations of Zn and Ca ( $P \leq 0.01$ ). Silver fox females had significantly higher concentrations of K, Fe and Pb ( $P \leq 0.01$ ) than Arctic fox females which showed significantly higher concentrations of Co, Cu, Zn and Na ( $P \leq 0.01$ ) in striated muscle.

*Zivoc. Vyr., 38, 11: 979-988, 1993. In SLOV, Su. ENGL. 6 tables, 8 refs. Authors' summary.*

### **The majority of vitamin A is transported as retinyl esters in the blood of most carnivores**

*Florian J. Schweigert, Oliver A. Ryder, Walther A. Rambeck, Hermann Zucker*

1. In canines and mustelides total vitamin A was 10-50 times higher compared to other species due to a high amount of retinyl esters (40-99% of total vitamin A) in blood plasma. The dominant vitamin A ester was in most species retinyl stearate. 2. In Ursidae, Procyonidae, Viveridae and Felidae, total vitamin A was much lower. When present, however, retinyl esters also represented 10-65% of total vitamin A in plasma. 3. Only retinol was detected in the plasma of the family, Hyaenidae, and the suborder, Pinnipedia. 4. In maned wolf cubs it was found that retinol, retinyl esters and  $\alpha$ -tocopherol

increased with the age of the animals, reaching values comparable to adult animals at the age of 5 months.

*Comp. Biochem. Physiol. Vol. 95A, No. 4, pp 573-578, 1990. 2 tables, 27 refs. Authors' abstract.*

### Novel aspects in vitamin A metabolism in the order carnivora - a review

*F.J. Schweigert, H. Zucker*

Vitamin A transport in the blood of most species in the order carnivora is fundamentally different from other animals and man. Very high levels of vitamin A in blood plasma of canines and mustelides are due to a high percentage of retinyl esters. These esters (basically retinyl palmitate and stearate) are transported nonspecifically bound to lipoproteins with very-low and low density lipoproteins representing the major fractions (about 70% of total vitamin A esters). A high percentage of retinyl esters could also be found in the families ursidae, procyonidae, viveridae and felidae in which total vitamin A in the blood was low. In man and rat severe signs of vitamin A intoxication can be observed due to a similarly high percentage of nonspecifically bound vitamin A esters. No clinical or clinical-chemical signs of vitamin A intoxication were observed in the animals investigated. Because vitamin A esters are transported by lipoproteins, their blood levels are readily affected by dietary vitamin A supply as is known to be the case for vitamin E. Furthermore, canines seem to be the only ones that excrete vitamin A as retinol and retinyl esters (basically retinyl palmitate) under physiological conditions with the urine. These fat-soluble metabolites of vitamin A are bound to a protein with a molecular weight between 50000 and 125000 Da which shows characteristics of a lipoprotein when subjected to ultracentrifugation or selective precipitation. Higher levels of vitamin A in organs and tissues, as well as the excretion of vitamin A with the urine, might be a consequence of the nonspecific binding of large amounts of retinyl esters to lipoproteins in blood. The physiological importance of these novel aspects of vitamin A metabolism in the order carnivora is, how-

ever, as yet unknown. Furthermore, because of these differences, the dog would represent an interesting model for studying the relationship of nonspecifically bound vitamin A esters to toxicity in hypervitaminosis A.

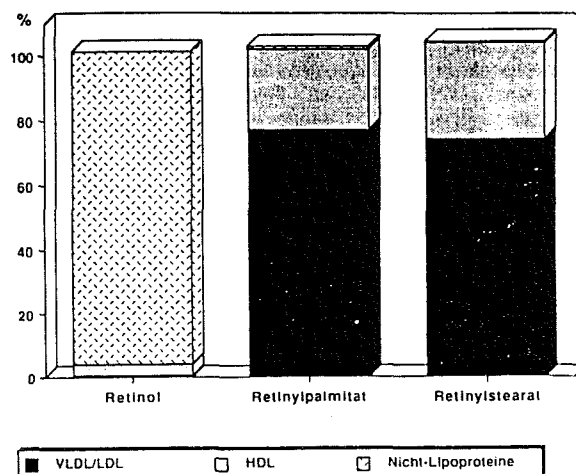


Abb. 1 Prozentuale Verteilung von Retinol und den Vitamin A-Estern auf die Lipoproteinfraktionen des Plasmas von Hunden (n = 11, Mittelwerte)

*Berl. Münch. Tierärztl. Wschr. 104, pp 89-98, 1991. In GERM, Su. ENGL. 3 tables, 2 figs., 41 refs. Authors' summary.*

### The mink as a model to study vitamin A metabolism in carnivores

*Ingeborg Buchholz, Ulf Dieter Wenzel, Florian J. Schweigert*

Carnivores are unique in the animal kingdom with regard to vitamin A metabolism. In these species vitamin A levels in the blood are considerably higher, which is exclusively due to a high percentage of retinyl esters bound to lipoproteins. Despite this non-specific vitamin A transport no signs of intoxication can be observed (Schweigert et al., 1990). In addition, most carnivores excrete significant amounts of vitamin A (retinol and retinyl esters) with the urine (Schweigert et al., 1991). To investigate these major differences in vitamin A metabolism a model species is desirable. Nine adult female mink (*Mustela vison*) were investigated with regard to the vitamin A plasma transport, the vitamin A distribution in tissue (liver, kidney, lung, heart, skeletal muscle, spleen, adipose tissue) as

well as the excretion of vitamin A with the urine. Tissue samples were homogenized, extracted and saponified (adipose tissue only). Organic extracts were subject to a gradient rp-HPLC separation, followed by detection (325 nm) and peak characterization using a photodiode array.

In plasma, vitamin A esters (mainly palmitate and stearate) were bound to lipoproteins, representing 92% of total vitamin A (mean 4.2 µg/ml plasma). High levels in liver (1441.4 µg/g tissue) and kidney (427.0 µg/g) were due to esters (94-99%). Up to 11 different retinyl esters could be identified. In all cases retinyl palmitate represented the major ester, followed by stearate and oleate. No vitamin A could be detected in the urine.

These results correspond well with those obtained for dogs and foxes, except for the low percentage of retinol in tissue and the lack of vitamin A excretion with the urine. The latter might be due to a possibly low supplementation with the feed. Thus, the mink might be a useful model to study vitamin A metabolism in carnivores.

*Retinoids. New trends in research and clinical applications. Opening lecture. Genoa, Italy, October 4-7, 1993. Only summary received (2 refs). Authors' summary.*

### **Carotenoids in man and animals: absorption, transport and metabolism**

*Florian J. Schweigert*

Carotenoids are essential as systemic and/or local vitamin A precursors. Absorption in the gut, lipoprotein distribution in plasma and distribution in tissues show that individual carotenoids are handled differently within a species as well as between species. With regard to carotenoid absorption in the gut humans absorb β-carotene as well as carotenoids, cattle and horses preferentially absorb β-carotene, while pigs, goats, sheep and rodents do not absorb carotenoids well, but all of them convert β-carotene into vitamin A. Little is so far known with regard to cellular uptake and intracellular handling of β-carotene except from its function as a vitamin A precursor. Its importance as an

antioxidant or a specific independent function cannot be excluded.

*Vitamine und weitere Zusatzstoffe bei Mensch und Tier, 4. Symposium 30.9.-01.10.1993 Jena (Thüringen), pp 5-14. In GERM, Su. ENGL. 4 tables, 68 refs. Author's summary.*

### **Vitamin A in blood plasma, tissues and urine of mink analysed with HPLC and photodiode array**

*I. Buchholz, U.D. Wenzel, F.J. Schweigert*

Mink were investigated with regard to the vitamin A plasma transport, the vitamin A distribution in tissue (liver, kidney, lung, heart, spleen, skeletal muscle) and the excretion of vitamin A with the urine. Organic extracts of plasma and tissues were subject to a gradient rp-HPLC separation, followed by detection (325 nm) and peak characterization using a photodiode array. High vitamin A levels in liver and kidney were due to esters (> 90%). Up to 11 different retinyl esters could be identified. In all cases retinyl palmitate represented the major ester. No vitamin A could be detected in the urine.

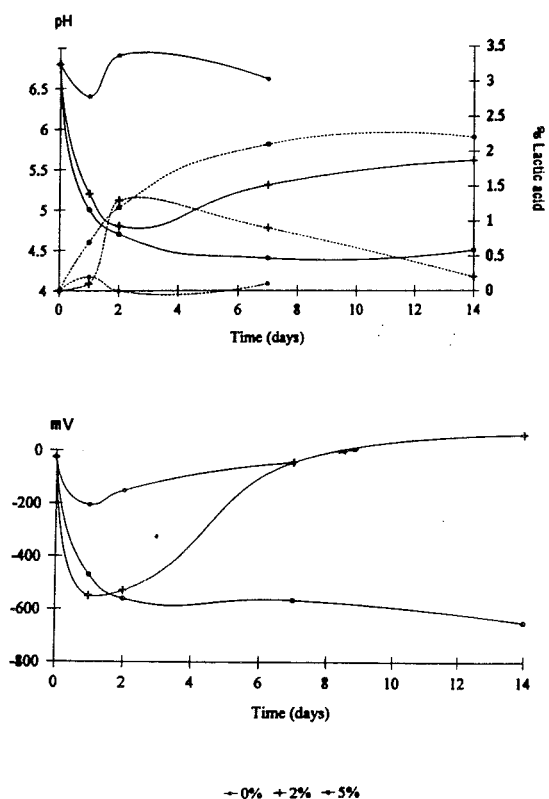
*Vitamine und weitere Zusatzstoffe bei Mensch und Tier, 4. Symposium, 30.9.-01.10.1993, Jena (Thüringen), Germany, pp 31-34. In GERM, Su. ENGL. 1 table, 11 refs. Authors' abstract.*

### **Evaluation of conditions for fermentation of fish offal**

*T. Mikael Lassén*

Conditions for the lactic acid fermentations of fish offal were evaluated regarding the effect of substrate concentration (2.5 and 10% dextrose), preacidification with lactic acid (initial pH of 6.8, to 6.5 or 6.0), and inoculum size of *Lactobacillus plantarum* ( $10^7$ ,  $10^8$  and  $10^9$  colony forming units (cfu)/g). pH and lactic acid production were monitored during a two-week storage period. A small-scale silo for fermenting fish offal was also constructed, and measurement of redox potential was evaluated as a means to estimate bacterial growth conditions. The most favourable conditions for

fermentation, manifested by a low and stable pH and high lactic acid production, were achieved with an inoculum size of  $10^8$  cfu/g and 5% dextrose. Preacidification did not affect final pH. Redox potential was shown to give a reliable estimate of growth conditions for bacteria under anaerobic conditions by rapidly falling to below -550mV in silage with a high lactic acid concentration.



**Fig. 1.** Fermentation of herring offal with  $10^7$  colony forming units/g of *Lactobacillus plantarum* at 25°C, a) -- changes in pH ---- &% LA. b) -- redox potential.

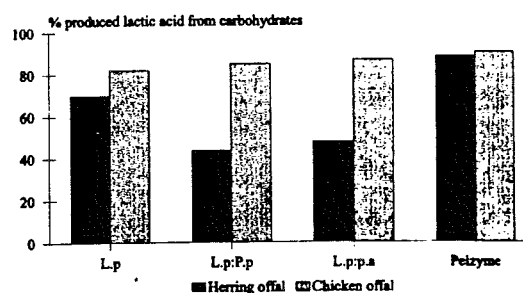
*Agricultural Science in Finland, Vol. 4, pp 11-17, 1994. 1 table, 1 fig., 25 refs. Authors' summary.*

**Lactic acid fermentation of fish offal and chicken by-products with different starter cultures**

*T. Mikael Lassén*

Lactic acid fermentation was evaluated as a method to preserve fish and chicken by-products. Herring (*Clupea harengus*) by-products (viscera and heads) and chicken by-products (heads, viscera, feathers, feet and discarded whole chickens) were minced,

mixed with 5% dextrose and inoculated with  $10^8$  colony forming units (cfu)/g of four different lactic acid bacteria cultures. The by-product was fermented at 25°C and evaluated for pH, % produced lactic acid, redox potential and odour during four weeks' storage. In herring offal, pH decreased from 6.8 to 4.2 in one week and stabilized at about 4.3. In the same time, 2.0% to 3.2% lactic acid was produced and concentrations stabilized from 2.5% to 4.0%. In chicken offal, pH decreased to a stable level of 4.4, and 3.2% lactic acid was produced after one week of fermentation. A negative and stable redox potential was achieved after one week of fermentation in both herring and chicken offal.



**Fig. 3.** LA production from 5% dextrose for different LAB cultures ( $10^8$  colony forming units/g) in silage made from herring and from 5% dextrose and 12% extruded wheatmeal:feather (2:1) in silage made from chicken offal at 25°C.

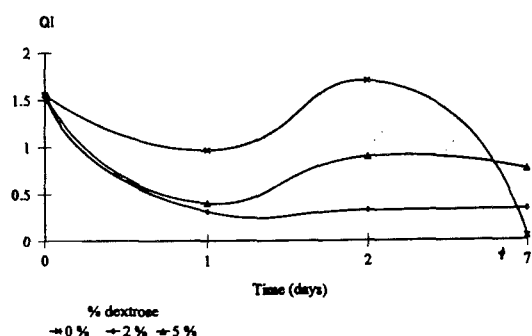
*Agricultural Science in Finland, Vol. 4, pp 19-16, 1994. 2 tables, 3 figs., 32 refs. Authors' summary.*

**Biological quality of fermented fish offal and chicken by-products**

*T. Mikael Lassén*

The biological quality of fermented animal by-products prepared from fish and chicken offal was evaluated. A quality index (QI) based on analyses of a few important free amino acids and their corresponding biogenic amines was given. A group separation method based on ion exchange chromatography was found suitable for isolating and purifying amines and amino acids in biological samples. Quality was evaluated in samples fermented with different starter cultures, inoculation sizes and

substrate levels. Slow or incomplete fermentation led to the accumulation of biogenic amines, especially tyramine, and resulted in a low QI. Fast initial and continuous stable fermentation for four weeks resulted in low concentrations of biogenic amines and high concentrations of free amino acids and consequently a high QI. The alanine concentration was considered to be a useful tool for estimating proteolysis, and QI related to changes in alanine concentration, lactic acid production and redox potential were considered to give the most useful estimation of the biological quality of fermented fish offal and poultry waste.



**Fig. 1.** Quality index (QI) for herring offal (silos 1-3) fermented with  $10^7$  colony forming units/g *Lactobacillus plantarum* and 0, 2, and 5% dextrose at 25°C.

*Agricultural Science in Finland, Vol. 4, pp 27-33, 1994. 1 table, 3 figs., 16 refs. Author's summary.*

### The influence of various contents of meat-fish ingredients in the feed of polar foxes on the selected hematological ratio, weight gain and fur skin trade value

*H. Bieguszewski, B. Glowinska, L. Narewski, M. Kasprzak*

Four groups of 60 young polar foxes were tested. Meal ration of the control group (K) contained 50% meat-fish ingredients. Meat-fish fraction was reduced to 15% for the experimental group no. 1 (D<sub>1</sub>) and to 30% for the experimental group no. 2 (D<sub>2</sub>). Both experimental groups had a different supplement of the amino acids lysine and methionine in their diet. Experimental group no. 3 (D<sub>3</sub>) had the portion of meat-fish ingredients increased to 70%.

The lower contents of Hb and of hematocrit ratio were noticed in groups D<sub>1</sub> and D<sub>2</sub> as compared to the control group. The overall protein ratio was lower in all experimental groups than the control group.

Reduction of animal products from 50% to 30% and the supplement of lysine and methionine, as well as a diet with a high ratio of meat-fish products (70%) in the feed resulted in a higher activity of blood plasma transaminases.

A significant body weight loss was statistically observed just before slaughtering in foxes on a 15% meat-fish diet supplemented with 0.5% lysine and 0.25% methionine.

*Zeszyty Naukowe no. 186 - Zootechnika 25, pp 11-20, 1994. In POLH, Su. ENGL. 6 tables, 13 refs. Authors' summary.*

### Probiotic use in the management of coypus

*K. Süvegová, D. Mertin, E. Oravcová, J. Rafay*

The effects of some probiotics on the growth of the young of standard coypu and on their health were tested in a trial conducted on the Farm of Fur-bearing Animals of the Research Institute of Animal Production at Nitra.

The trial involved nine newly established families of coypus (one male and three females) raised in a shed in cages with water runs and which received a pelleted mixture KK. The experimental animals were divided into three experimental and one control group.

Probiotics mixed with meals were administered in the second half of pregnancy. Their administration continued until eight months of age. In the 1st experimental group the animals received the microbiotic preparation LACO (*Lactobacillus acidophilus* and *Escherichia coli* in milk powder) at a dose of 0.2 g per young until the age of four months and 0.3 g for the older animals. The animals of the second experimental group received the microbiotic MIKROBION SUPERMIX 0.1 TS (*Bacillus subtilis*, *Streptococcus faecalis* subsp. *zymogens*, *Streptococcus faecium* var. *durans* in milk powder) at a

dose of 1 kg per 1,000 kg feed twice a week. The third experimental group was given the antibiotic premix IVAMIX (Linkospectin concentrate 0.85 g/kg, rapeseed oil, wheat flour) at a dose of 1 kg per 1,000 kg feed for seven days once a month.

The youngs' weight was determined by monthly weighing from birth to eight months. The results of the records were processed and assessed by statistical methods. The health of the animals in all groups did not change during the trial. In the trial, positive effects of microbionics (particularly of the preparation MIKROBION SUPERMIX 0.1 TS) were found as exerted on the live weight of the newborn as well as on their growth in the first two months of age. The positive effect of microbionics was also determined at five months when the feed ration formulation was changed (supplemental feeding of green fodder).

The growth of the animals was positively influenced by administration of the antibiotic premix IVAMIX in the third to seventh months of age. The effect of sex on the live weight was observed in the fourth month of age in favor of the males, while it was more conspicuous from the sixth month, but no relationship to probiotic administration was determined.

*Zivoc. Vyr.*, 39 (3), pp 239-245, 1994. In *CHECH*, Su. ENGL. 3 tables, 9 refs. Authors' summary.

#### **Economic efficiency of balanced concentrate mixtures in feeding young nutria**

*S. Niedzwiadek, M. Piorkowska, G. Palimaka-Rapacz, M. Rynski, W. Dudziuk*

Studies were conducted on a total of 240 young nutria of greenland variety fed various diets in summer and winter seasons. The animals were divided into 3 groups of 40 each in either feeding season. Group I nutria were fed by the traditional system; group II was given a balanced mixture with protein levels of 12-13% and fiber 9-10%, supplemented with green fodder during summer feeding and with root crops in winter; group III was fed a balanced mixture with protein levels of 15-16% and fiber 9-10% supplemented with green fodder or root crops like in group II.

It was found that the formulated composition of the balanced concentrate mixtures with a protein level of ca. 16% proved very effective in feeding nutria. The young animals were characterized by a high growth rate, attaining at 8 months a body weight of 5 kg (males) and 4.6 kg (females). Nutrient utilization was very good, allowing a decrease in concentrate consumption in early growth by ca. 2 kg compared to nutria fed traditionally. Average grade of pelts was 2.4-2.6 depending on feeding season.

*Rocz. Nauk. Zoot. T. 20, z 1, pp 143-155, 1993. In POLH, Su. ENGL, GERM, RUSS. 9 tables, 16 refs. Authors' summary.*

#### **Utilization of carcass fat of nutria**

*Zou Zinghuai, Zou Qi, Wang Linggang*

This paper made a comparative analysis of fat from nutrias, raccoon dogs, and lard. The result indicates that the content of C18:2 fatty acid in nutrias fat is 24.78 percent of that which is essential for human. This content is twice that in raccoon dogs. Except for C18:2 fatty acid, the content of vitamin A and E in the fat of nutrias is also higher than raccoon dogs while the former is 8.24 and 24.98 percent respectively. The third good quality of nutrias fat is that its chemical character is steadier than that of the fat of raccoon dogs and lard. Therefore the fat of nutrias has great value to be exploited. The utilization in compounding cosmetics is its excellent effect on the nutrition of skin and hair protection.

*Chinese Wildlife, No. 1, pp 43-45, 1993. In CHINA Su. ENGL. 6 tables, 1 fig. Authors' summary.*

#### **A study on raccoon dog fat**

*X.H. Zou, L.G. Wang, Q. Zhou, G.L. Leui*

The carcass fat of raccoon dogs has not been exploited and utilized. In order to increase the economic benefit from raccoon dog breeding, the author determined in the end of 1989 the physical and chemical indivrd and the contents of nutritive elements in the fat of raccoon dogs. The results show that, 1) the content of unsaturated fatty acids in



raccoon dog fat is lower than that in vegetable oil; 2) the iodine value of raccoon dog fat is lower than that of lard, suet and cattle fat; 3) there are rich levels of vitamin A (0.45  $\mu\text{g/g}$ ), vitamin E (0.28  $\mu\text{g/g}$ ) and C18:2 fatty acid (12.88 percent) in raccoon dog fat; 4) the pH value of raccoon dog fat is identical to that of human skin. For the above reasons, the fat of raccoon dogs can be used in compounding cosmetics as one kind of fine material of the oil phase.

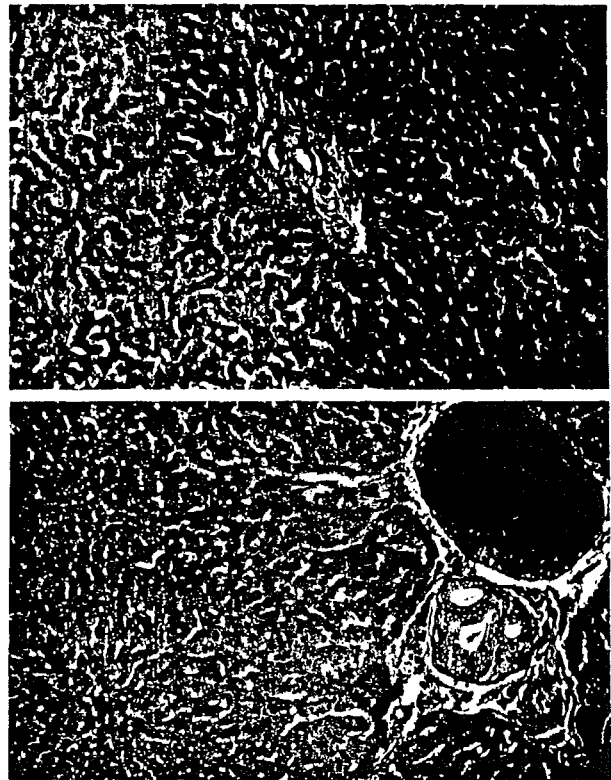
*Maopi Dongwu Siyang No. 4, pp 9-11, 1989. In CHIN, Su. ENGL. 4 tables, 4 refs. Authors' summary.*

#### Dietary exposure of mink to carp from Saginaw Bay, Michigan: 2. Hematology and liver pathology

*S.N. Heaton, S.J. Bursian, J.P. Giesy, D.E. Tillitt, J.A. Render, P.D. Jones, D.A. Verbrugge, T.J. Kubiak, R.J. Aulerich*

The effects of consumption of environmental contaminants contained in carp (*Cyprinus carpio*) from Saginaw Bay, Michigan on various hematological parameters and liver integrity of adult female mink (*Mustela vison*) were determined. Mink were fed diets that contained 0 (control), 10, 20, or 40% carp prior to and throughout the reproductive period (182 days). The diets contained 0.015, 0.72, 1.53, and 2.56 mg polychlorinated biphenyls (PCBs)/kg diet and 1.0, 19, 40, and 81 pg 2,3,7,8-tetrachlorodibenzo-*p*-dioxin equivalents (TEQs)/g diet, respectively. Mink fed the diets containing carp showed a general dose-dependent occurrence of clinical signs commonly associated with chlorinated hydrocarbon toxicity, including listlessness, nervousness when approached, anorexia, and melena. Erythrocyte counts were less in mink exposed to Saginaw Bay carp than in controls, while the number of white blood cells was greater than in controls. Significant differences ( $p < 0.05$ ) in the concentrations of neutrophils, lymphocytes, monocytes, and eosinophils were also found between the control and carp-fed groups, but are considered to be of limited clinical or biological importance. Hematocrit values for the mink fed the 20 and 40% carp diets were significantly less than those of

mink in the control and 10% carp groups. There were no significant differences in hemoglobin concentrations among the groups. Necropsies revealed enlarged yellowish livers in many of the carp-fed mink, especially those fed the 40% carp diet. Liver, spleen, and lung weights of carp-fed mink were significantly greater than those of control mink. Histopathologic examination of the livers revealed various degrees of congestion, hepatocellular fatty changes, and scattered portal lymphocytic infiltration which were most prevalent in mink fed the carp diets. These clinical signs, hematological effects, and histologic alterations are similar to those previously described for chlorinated hydrocarbon toxicoses in mink.



**Fig. 1.** Above. Section of liver from a control mink showing no histological lesions. Hepatocytes are normal with very little lipid accumulation. Sinusoids appear free of congestion (140x). Below. Section of liver with diffuse hepatocellular lipidosis from a mink fed 40% carp (560x; sections stained with hematoxylin and eosin).

*Arch. Environ. Contam. Toxicol. 29, pp 411-417, 1995. 3 tables, 1 fig., 58 refs. Authors' summary.*

### Fish oil as an energy source for blue foxes (*Alopex lagopus*) and mink (*Mustela vison*) in the growing-furring period

Ø. Ahlstrøm, A. Skrede

This investigation addressed the effects of fish oil given in different dietary fat:carbohydrate (F:C) ratios on digestibility, some physiological parameters and production performance in blue foxes and mink. Blue foxes digested the main nutrients more efficiently than did mink. Increasing the F:C ratio resulted in faster growth and heavier final body weights in blue foxes, but had no such effect on growth performance in mink. Analysis of blood lipids and plasma compounds related to the anti-oxidative system and liver vitamin E revealed few significant differences between diets. In mink, there was a significant relationship between dietary level of fish oil and vitamin-E status. Significant differences between species were found for hematocrit, hemoglobin, plasma vitamin-E, liver vitamin E, plasma triacylglycerols, plasma superoxide dismutase and plasma ASAT. As there were no clinical symptoms of malfunctions in the anti-oxidative system, it was concluded that both species tolerate high levels of good-quality fish oil. In blue foxes, fur-quality characteristics were highest in the intermediate F:C ratios, whereas the highest F:C ratio (60:10) tended to reduce skin length and length of guard fur.

*J. Anim. Physiol. a. Anim. Nutr.* 74, pp 146-156, 1995. 7 tables, 30 refs. Authors' summary.

### Feed with divergent fat: carbohydrate ratios for blue foxes (*Alopex lagopus*) and mink (*Mustela vison*) in the growing-furring period

Øystein Ahlstrøm, Anders Skrede

A study was carried out to investigate the effect of divergent dietary fat:carbohydrate (F:C) ratios on growth, general health status and fur quality in blue fox and mink during the growing-furring period. The F:C ratios, as percentages of metabolizable energy, ranged from 65:5 to 40:30. Lard and soybean oil were used as experimental fat sources and precooked wheat and oats, and extruded corn as carbohydrate sources. In blue foxes

(n=20), higher F:C ratios resulted in increased energy intake (ME), higher final body weight and longer skins. Neither health status nor fur quality in blue foxes was affected significantly by the F:C ratio. In mink (n=64) it was found that with the highest F:C ratios there seemed to be an increase in ME consumption per body weight gain. It was also found that very high F:C ratios had a negative effect on fur quality in mink, possibly owing to impaired guard hair growth. We conclude that blue foxes can tolerate higher F:C ratios than mink.

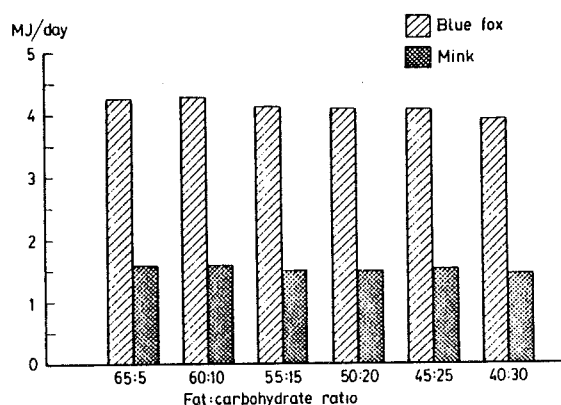


Fig. 1. Daily energy (ME) consumption.

*Norwegian Journal of Agricultural Sciences* 9, pp 115-126, 1995. 8 tables, 1 fig., 20 refs. Authors' summary.

### Comparative nutrient digestibility in blue foxes (*Alopex lagopus*) and mink (*Mustela vison*) fed diets with diverging fat:carbohydrate ratios

Øystein Ahlstrøm, Anders Skrede

Nutrient digestibilities were evaluated in comparative experiments with blue foxes and mink by using six diets differing in fat:carbohydrate (F:C) ratios. In mink, apparent digestibilities of N and amino acids decreased with decreasing F:C ratio. N digestibility, and most amino acid digestibilities, were higher in blue foxes than in mink ( $P < 0.01$ ). Fat digestibility in mink, but not in blue foxes, declined as the F:C ratio decreased ( $P < 0.05$ ). Fat digestibility was higher in blue foxes than in mink ( $P < 0.05$ ). Carbohydrate digestibility was not affected by the F:C ratio, but high levels of carbohydrates were digested more completely by foxes than

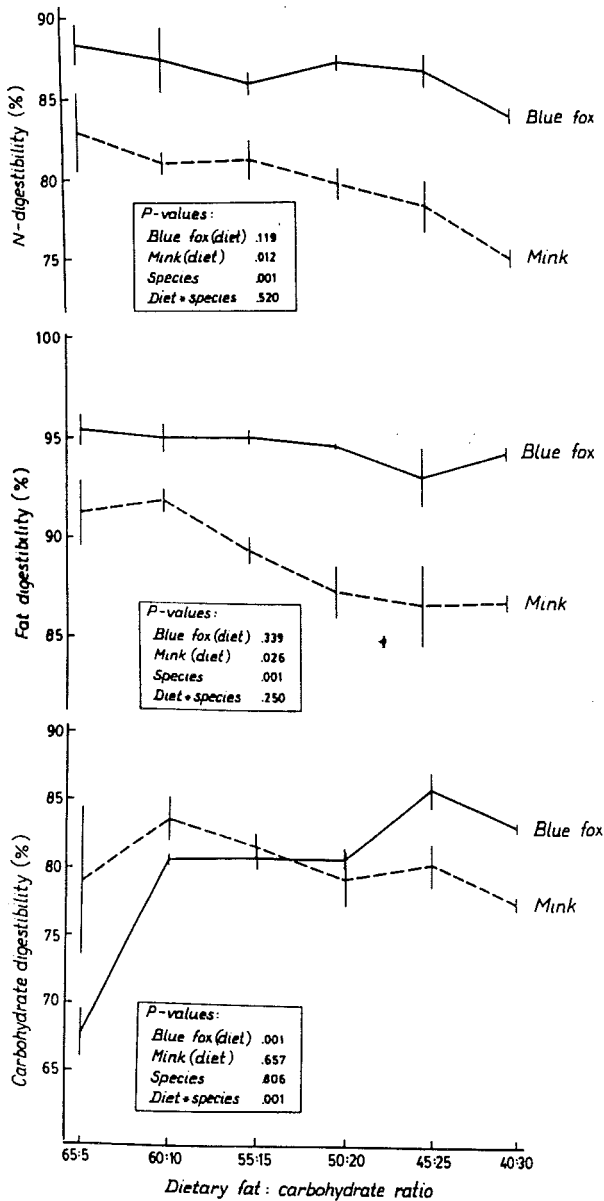
by mink. The use of mink digestibility values in feed evaluations for blue foxes will consequently underestimate digestibility. Thus, to evaluate feed correctly, separate digestibility determinations should be made for mink and foxes.

**Summer diet of the sable *Martes zibellina* in the Middle Yenisei taiga, Siberia**

*Marcin Brzezinski*

The summer food of the sable *Martes zibellina* Linnaeus, 1758, inhabiting taiga forests near Mirny Field Station on Middle Yenisei, Siberia, was studied by the analysis of 136 scats. *Microtinae* rodents (mainly northern red-backed vole *Clethrionomys rutilus*) constituted 52.3% of the biomass consumed by sables. Plant food (seeds of Siberian pine *Pinus sibirica* and berries of *Vaccinium* sp.) was also frequently eaten; it occurred in 79.4% of scats but constituted only 19.9% of the biomass. Shrews, burunduks *Eutamias sibiricus*, birds and insects were supplementary food; however, these groups of prey formed totally about 25% of the consumed biomass.

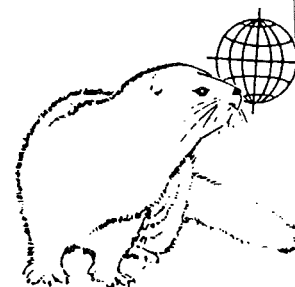
*Acta Theriologica* 39 (1), pp 103-107, 1994. 1 table, 20 refs. Author's summary.



**Fig. 1.** Effect of dietary fat:carbohydrate ratio on nitrogen (N) digestibility, fat digestibility and carbohydrate digestibility in blue foxes and mink. Variation is given as standard error of the mean.

*Acta. Agric. Scand. Sect. A, animal Sci.* 45, pp 74-80, 1995. 4 tables, 1 fig., 24 refs. Authors' summary.





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Original Report

## Isolation and identification of mink mycoplasma recovered from a ranch with *Pseudomonas*-infection history

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### Abstract

Two strains of *Mycoplasma* were recovered from the trachea and apical lobe of the lungs from 8-month clinically normal mink pertaining to a farm which had had a recent outbreak of *pseudomonas aeruginosa* Pneumonia. According to the morphological, biochemical and serological tests performed on both strains, it can be concluded that these isolates are *Mycoplasma mustela*. Its role in mink pathology remains unclear.

### Results

*Pseudomonas aeruginosa* is known to produce acute pneumonia in mink (*Mustela vison*) worldwide (Long and Gorham, 1982; Nordstoga, 1992) and has been a serious problem among our farms for a long time (Martino and others, 1991).

During the autumn months of 1994, tens of dead standard wild and dark mink (between 5 and 6 months old) were received at our institution from a ranch with a recent outbreak of *Pseudomonas aeruginosa*-infection. The animals had not been vaccinated and mortality reached up to 23% of the herd. At necropsy, the animals exhibited significant

lung pathology and *Pseudomonas aeruginosa* was easily isolated from the pneumonic lesions in pure culture. Serotyping of the strains using the Difco System (Elsading-Elsheik and others, 1984) proved them to be serotypes 6 and 8. Furthermore, serotype 6 was the most common among the strains isolated in the past years in our country (Meyerland, 1985; Martino and others, 1991). Attempts to isolate *Mycoplasma* from these pneumonic cases were unsuccessful.

Two months later, at pelting time on the same ranch, samples of trachea and lung from apparently normal mink of 8 months, which survived the outbreak, were bacteriologically investigated.

Samples for Mycoplasmal culturing were moistened in sterile Modified Hayflick (HM) broth containing penicillin and thallium acetate inhibitors (Friis and others, 1991; Freundt, 1983). Cultures were incubated at 37°C in 8% CO<sub>2</sub>-atmosphere. Subculturing of the inoculated broth was done on days 3 and 6 by plating a 250-µl sample of the well-mixed broth to a modified Hayflick agar plate. These plates were incubated at 37°C in 8% CO<sub>2</sub>-atmosphere for 10 days before being discarded as negative. In the case of heavily contaminated cultures (mostly with

Gram-negative germs) isolation was reattempted after addition of cycloserine, vancomycin and nalidixic acid to the medium and also after filtration through 450 µm pore membranes (millipore). Plates were examined daily with 40x magnification (with an Olympus Microscope BH2, Japan) and reduced light for signs of typical "fried egg" appearance of mycoplasmal colonies.

Two mycoplasma strains were isolated from 2 animals (from trachea and apical lung lobe in the first case and from trachea in the second one) between the third and fourth day-incubation when "fried-egg" colonies appeared. Pleomorphic, filamentous and cocci forms were observed on Giemsa-stained preparations, according to Fallon-Whittlestone (1969). Colonies of both strains were recovered after filtration through millipore membrane filters (300 µm pore diameter) from liquid to solid medium. For the reversion test, HM solid mediums without antibiotics were five times inoculated and without antibiotics were five times inoculated and "fried-egg" colonies were obtained. These were further characterized as *Mycoplasma* species by means of the digitonin test when no growth was observed around the disk (Erno and Stipkovits, 1973).

PPLO (pleuropneumonia-like organisms) free serum medium (Oxoid) was inoculated in order to investigate cholesterol requirements (Holt, 1986). In addition, both strains were found to be susceptible to showing an ample zone of inhibition. Among the biochemical studies performed on both strains, aerobic and anaerobic glucose fermentation, and phosphatase tests were all positive, while arginine and urea hydrolysis (on *Ureoplasma* Standard agar medium A5K) were negative. 2,3,5 triphenyltetrazolium chloride was not reduced aerobically and anaerobically, and a film and spot reaction was produced.

Half-litter cultures of each cloned isolate in PPLO broth were harvested, washed and used to prepare antiserum in rabbits (Ball, 1981) and these antisera were tested against each isolate using the growth inhibition (Clyde, 1964) and metabolic inhibition (Senterfit and Jensen, 1966) tests. The tests were also done employing 2 rabbit anti-*mycoplasma Mustela* serum: anti-serum against strain L2A provided by Dr. S. Kazama (Nippon Institute for

Biological Science, Japan) and an anti-serum against Mx 9 provided by Dr. Friis.

Under serological investigation by growth inhibition test (GIT), reactions of both strains were similar to that of Mx 9 strain (provided by Dr. N.F. Friis of the National Veterinary laboratory, Denmark) disk saturated anti-serum decreased colony size of *Mycoplasma* ( $10^4$  -  $10^6$ ) on agar plate (growth did not inhibit perfectly). Under metabolism inhibition test (MIT) both mentioned anti-serums inhibited the strains ( $10^3$ ) in 1 ml broth medium (Kazama, 1994). Both strains were screened by indirect Epi-Immuno-fluorescence test to identify colonies, using the block agar methods (Gardelly and others, 1983). The whole cell protein of the isolates was analyzed on a SDS poly-acrylamide gel (Laemmli and others, 1970) showing a close similarity with the two strains of *Mycoplasma mustela* (LA2 from Dr. Kazama and MX9 from Dr. Friis).

Taking into account the morphological (very pleomorphic, ranging from coccoid to filamentous forms) biochemical, whole cell protein and serological results, we can assume that these two isolates appeared to be *Mycoplasma mustela* (Salih and others, 1983; Friis, 1994).

*Mycoplasma* is not a frequently occurring microorganism in mink. This relatively new *mycoplasma* species was identified for the first time by Salih and others (1983) who recovered three strains (Mx 9, Mx 9 and Mx 11) from the normal lungs of mink kits.

Recently there has been an increased interest on these small prokaryotes and a greater appreciation of the role in the disease process. For example, there is a current awareness that *Mycoplasma* are involved in human and animal infections much more frequently than had been generally supposed but studies on these germs in furbearing animals has always lagged behind those on other aerobic or anaerobic organisms, mainly because of technical difficulties and inconveniences.

Regrettably, the size of the investigated group of animals here was too small to make definite conclusions on the colonization of mink with *Mycoplasma mustela*. Obviously further studies are needed to clarify the *Mycoplasma mustela* role in

mink pathology and whether it is a common bacteria of the endogenous flora of the upper and low respiratory tract of mink or not.

**Acknowledgements**

The authors are deeply grateful to Dr. S. Kazama (Nippon Institute for Biological Science, Japan), to Dr. N.F. Friis (National Veterinary Laboratory, Denmark) for supplying the antisera against *M. Mustela* and *M. Mustela* strain Mx 9, and to Dr. T. Meyerland (The National Veterinary Institute, Uppsala, Sweden) who kindly serotyped our *Pseudomonas aeruginosa* strains.

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Original Report

**Insecticide action of Polwet 5, Polwet 20 and Polwet aerosole  
(methylbrompheninfos) against external parasites  
(*Sarcoptes scabiei v. canis*, *Otodectes cynotis*, *Chaetopsylla globiceps*)  
in polar and silver foxes**

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**Summary**

The aim of the investigation was to test the effectiveness of Polwet 5, Polwet 20 and Polwet aerosol containing methylbrompheninfos, an insecticide of the enolophosphate group, as the active substance against external parasite infestation in polar and silver foxes.

Methylbrompheninfos in its therapeutic forms - Polwet 5 and Polwet 20 is effective against itch mite, *Sarcoptes scabiei v. canis*, in polar foxes while Polwet 5 is effective against aural itch mite, *Otodectes cynotis*, in silver foxes. Polwet aerosol controls infestations with fleas, *Chaetopsylla globiceps*, in polar foxes.

**Introduction**

Methylbrompheninfos is the second enolophosphate synthesized in Poland. In view of its relatively low toxicity, particularly dermal, it aroused the interest of the Polish veterinary centers as a possible drug to be used against external parasites. That

suggestion was confirmed by many parasitologic investigations. The use of therapeutic forms of methylbrompheninfos - Polwet 5 and Polwet 20 in the spring and autumn therapy proves its great effectiveness against cattle botfly (*Hypoderma bovis*), cattle mallophagus (*Bovicola bovis*), Sheep mallophagus (*Bovicola ovis*), sheep itch mite (*Pssoroptes ovis*) and Melophagus ovinus.

Polwet 5, Polwet 20, and Polwet aerosol release pigs from pediculosis (*Haemotopinus suis*) and scabies (*Sarcoptes scabiei v. suis*). Polwet 5 and Polwet 20 used in chickens against external parasites of the genus *Dermanyssus gallinae*, *Liperus* sp. and *Ceratophyllus gallinae* showed a high degree of effectiveness (Sciesinski, 1994). The investigations in vitro by Zlotorzyczna et al. (1982) demonstrated a high susceptibility of chicken external parasites to the action of Polwet 5. Particularly susceptible is *Dermanyssus gallinae*. Menopon gallinae, *Eomenacanthus stramineus*, and *Gomocetes gallinae* proved to be more resistant. Further investigations in vivo of Polwet 5, Polwet 20, and Polwet aerosol by Zlotorzyczna et al. (1982) fully confirmed the



high effectiveness of those preparations against external parasites in the chicken. With good therapeutic results Polwet 5, Polwet 20 and Polwet aerosole control the invasion of fleas (*Ctenocephalides canis* and *C. felis*) in dogs and cats and ticks in dogs (*Ixodes ricinus*, *Dermacentor pictus*) and combats scabies in dogs (*Sarcoptes scabiei v. canis*).

The aim of the investigation was to examine the effectiveness of Polwet 5, Polwet 20, and Polwet aerosole (methylbrompheninfos) against *Sarcoptes v. canis*, *Otodectes cynotis*, and *Chaetopsylla globiceps* in polar and silver foxes.

### Material and methods

The effectiveness of Polwet 5, Polwet 20, and Polwet aerosole (containing methylbrompheninfos as the insecticide) was examined against the following external parasites: itch mites (*Sarcoptes scabiei v. canis* and *Otodectes cynotis*) and fleas (*Chaetopsylla globiceps*) in polar and silver foxes.

In the case of *Sarcoptes scabiei v. canis* in polar foxes the 1% Polwet 5 aqueous emulsion (5% methylbrompheninfos) and Polwet 20 (20% methylbrompheninfos) were used - the emulsion was rubbed 5 times every 3 days into the infected places; and 2.5% Polwet 5 oil emulsion (prepared of 1 part of Polwet 5 and 1 part of liquid paraffin) - that emulsion was rubbed into the areas attacked by aural itch mite. The treatment was repeated 5 times at 3 day intervals. The effectiveness of Polwet aerosole (0.1% methylbrompheninfos) was examined against the invasion of fleas (*Chaetopsylla globiceps*) in polar foxes. The preparation was applied twice and 3 times at 10 days intervals. The evaluation was performed on animals kept on cooperative farms. The age of the animals varied from 6 months to 4 years. The evaluation of the effectiveness of Polwet 5, Polwet 20, and Polwet aerosole against the ectoparasites in polar and silver foxes was performed in total on 71 animals.

### Results and discussion

The effectiveness of 1% Polwet 5 and Polwet 20 aqueous solutions against itch mite (*Sarcoptes scabiei v. canis*) was examined in polar foxes.

After 5 times repeated treatment of rubbing the infected areas the animal was fully released from the parasite (see Table 1).

Similar therapeutic procedure was applied in the case of diagnosing the aural itch mite (*Otodectes cynotis*) in silver foxes. Prior to the treatment one part of Polwet 5 and one part of liquid paraffin were mixed and the prepared emulsion was rubbed 5 times into the external auditory meatus in foxes. After repeated treatment of rubbing with the prepared emulsion the treated animals were completely released from parasites (see Table 1). No side effects of the applied preparations were observed in the treated animals.

Polwet 5, Polwet 20, and Polwet aerosole in which methylbrompheninfos is the active substance are characterized by an exceptionally favourable therapeutic index and significant effectiveness against external parasites in polar and silver foxes.

The applied doses did not cause any side effects in the treated animals.

### Conclusions

1. Methylbrompheninfos in its therapeutic forms - Polwet 5 and Polwet 20 releases animals from the invasion of scabies (*Sarcoptes scabiei v. canis*).
2. Polwet 5 effectively controls the aural itch mite (*Otodectes cynotis*) in silver foxes.
3. Polwet aerosole releases polar foxes from the invasion of fleas (*Chaetopsylla globiceps*).

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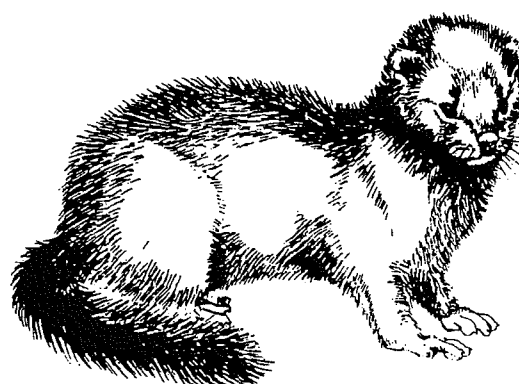
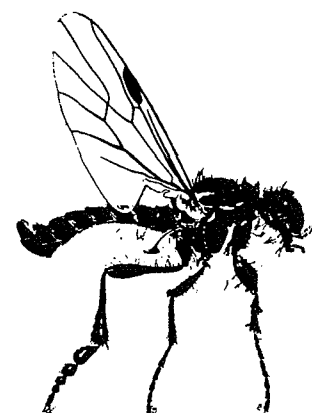
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**Table 1** External parasite control in polar and silver foxes with the help of Polwet 5, Polwet 20 and Polwet aerosole preparations

Animals			Applied preparation			
Host and parasite species	Number of animals	Average body weight (kg)	Commercial name of preparation	Solution ml/animal	Concentration (%)	Single dose mg/kg b.w.
<u>Polar fox</u> <i>Sarcoptes scabiei</i> <i>v. canis</i>	9	6	Polwet 5	15	1	15
	14	8	Polwet 20	15	1	20
<u>Silver fox</u> <i>Otodectes cynotis</i>	12	8	Polwet 5	5-10 (1 part Polwet 5, 1 part liquid paraffin)	2	10-20
<u>Polar fox</u> <i>Chaetopsylla globiceps</i>	46	6	Polwet aerosole	20	0.1	3

**Table 1 continued**

Animals	Application	Results of treatment	
		Number of animals completely cured	Average effectiveness (%)
<u>Polar fox</u> <i>Sarcoptes scabiei</i> <i>v. canis</i>	rubbing 5 times every 3 days	9	100
	- " -	14	100
<u>Silver fox</u> <i>Otodectes cynotis</i>	rubbing 5 times every 3 days	12	100
<u>Polar fox</u> <i>Chaetopsylla globiceps</i>	spraying twice every 10 days	46	100



*Original Report*

## **The method of the skin electrical conductivity measurement at the acupuncture points as a diagnostic measure evaluating the health state of particular systems and organs in animals. Part I.**

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### **Summary**

The present paper describes the Ryodorak method worked out by Nakatani and Hyodo (1975). That method shows a close connection between the functional state of internal organs and the values of electrical conductivity measured at the acupuncture points of proper meridians connected with those organs. The localized points are characterized by the increased electrical conductivity as compared to the conductivity of the neighbouring areas.

Those points, called the REPP (Reactive Electro-Permeable Points), reveal themselves in the pathological states of organs and systems and arrange themselves in lines corresponding to the acupuncture meridians. Those lines were described as Ryodoraku (ryo - good, do - conductivity, way, raku - line) that is the liens of good conductivity.

Each meridian has some representative measuring points (RIP) attributed to it - the mean value of those points equals the mean value of the electrical

conductivity of all the REPPs of the whole meridian.

On the basis of all the measurements taken at those points it can be determined whether the Ryodoraku value of a given patient is physiological or pathological.

This method has already been used in human medicine and it seems advisable to adapt it for the diagnostic purpose of veterinary medicine and practical needs of animal breeding.

### **Introduction**

For many decades now scientists have been looking for new therapeutic agents. Scientific research in recent years has resulted in the discovery of many new drugs and the application of modern technical equipment for therapeutic purposes.

Some years ago, the Chinese art of inserting thin needles into particular points of human body -

acupuncture, which was considered as a kind of traditional medicine in the Far East countries, was not accepted as an official branch of medicine practised in the European countries. However, thanks to the new view on medical problems, acupuncture found its due place among other accepted therapeutic methods. Soon it also found its way to veterinary medicine. The usefulness of that method for therapeutic as well as prophylactic purposes is presented, among others, in the scientific theses and scientific research (*Sciesinski, 1987, 1988*) carried out in the Animal Breeding Department of Warsaw Agricultural University - SGGW.

The method presented in this paper refers to the use of electroacupuncture as a diagnostic measure in determining the functional state of particular systems and organs of animals. It is a consecutive trial of proving the usefulness of acupuncture for prophylactic as well as therapeutic purposes.

#### *The Ryodoraku method*

The development of electronic measuring equipment allowed the appearance of the methods of electroacupuncture diagnostics. Among them, the Ryodoraku method worked out by Y. Nakatani is one of the, so far, most widely accepted and popular in human medicine.

Since 1950, research on the problem of the electrical resistance of biologically active points on the skin has been carried out in Osaka under the scientific supervision of the doctor of medicine, Yoshio Nakatani. They revealed a close dependence between the functional state of the internal organs and the values of electrical conductivity measured at the acupuncture points of the proper meridians related to those organs. The localized points are characterized by the increased electrical conductivity as compared to the conductivity of the directly neighbouring areas. Those points which are called REPP (Reactive Electro-Permeable Points) reveal themselves in the pathological states of given systems or organs and arrange themselves in lines corresponding to the acupuncture meridians. Those lines were termed Ryodoraku (ryo - good, do - conductivity, way, raku - line) which means the lines of good conductivity (*Hyodo, 1975*). Each meridian has the points called RMP (Representative Measuring Points) attributed to it for which the mean value of electrical conductivity equals the

mean value of electrical conductivity for all the REPPs of the whole meridian (Table 1). On the basis of the measurements taken at those points it can be determined whether the Ryodoraku value for a given patient is pathological assuming that the pathological Ryodoraku value as compared to the physiological one shows either increased or decreased electrical conductivity. Nakatani presents the opinion that the appearance of REPP closely connected with the pathological state of particular organs and systems can be explained by the viscerocutaneous reflex transmitted with the help of the sympathetic system nerves and presented as the following cycle: disorder of internal organs - sending the information impulses via the afferent nerves - converting the information in the spinal cord or brain areas - directing the information to the reflex zones on the skin surface - appearance of pathological value of REPP. At the same time the proper REPP stimulation results in the changes of the local stimulation of sympathetic nerves in correlation between the body surface and internal organs.

On that basis, it is assumed that REPP are also the points of treatment based on the above correlation and by a proper stimulation at those points one can affect the particular organs corresponding to a given Ryodoraku (*Nakatani, Yamashita, 1977*). The Ryodoraku method was defined by Nakatani as the "measurement of sympathetic stimulation of the skin surface, performed by the measurement of resistance and subjecting them to the stimulation regulating by the means of the nervous reflex the level of stimulation up to the normal state" (*Nakatani, Hyodo, 1975*). However, it should be stressed that the type of pathological state cannot be fully and objectively determined by the Nakatani diagnostic method. That method includes a certain type of information which helps establishing the kind of additional and, at the same time, absolutely necessary means of clinical laboratory diagnostics and other instrumental methods. "The drawback of the Ryodoraku method is impossibility of determining the degree of activity of two very important meridians: Main Frontal Regulator (Jen Mo) and Main Back Regulator (Tou Mo)". Nevertheless it is an indispensable method allowing the determination of the functional state of main meridians and also more than once the detection of the latent pathological syndrome of a given organ or system even before the clinical symptoms occur.

**Table 1.** Representative measuring points (RMP) of particular meridians (Ryodoraku). The relationship between Ryodoraku and the basic meridians (Nakatani, Hyodo, 1975)

Ryodoraku	Meridians	Organs	RMP (English transcription)	Literal-numerical RMP index		
				English	German	French
H1	I	Lungs	Tai-yuan	LU9	Lu9	P9
H2	IX	Pericardium	Ta-ling (Daling)	HC7	KS7	MC7
H3	V	Heart	Shen-men	Ht7	H7	C7
H4	VI	Small intestine	Yang-ku (Wangu)	SI5	Du5	IG5
H5	X	Lymphatic vessels	Yang-chi	TH4	3E4	TR4
H6	II	Large intestine	Yang-hsi (Yangxi)	LI5	Di5	GI5
F1	VI	Spleen	Tai-pai (Taihai)	SP3	MP3	RP3
F2	XII	Pancreas	Liver	LiV3	Le3	F3
F3	VIII	Kidneys	Tai-chung (Taichong)	Ki5	N5	R5
F4	VII	Urinary bladder	Shui-chuan (Taixi)	BI65	B65	F65
F5	XI	Gallbladder	Shu-Ku (Shugu)	GB40	G40	VB40
F6	XI	Gallbladder	Chiu-hsu (Qiuxu)	GB40	G40	VB40
F6	III	Stomach	Chung-yang (Chongyang)	St42	M42	E42

Meridians h1-H6 are located on the hand (Hand); Meridians F1-F6 are located on the foot (Foot); RMP - Representative Measuring Points

In view of the above that method is considered to be sensitive. It also allows the avoidance of other methods which are expensive, complicated and often dangerous for the patient (Hyodo, 1975). In the Ryodoraku method the therapy also includes points situated on the unpaired meridians which are also called the marvelous ones. They are the following: Ryodoraku VM - Conception (CV) - conception meridians oraz Ryodoraku HM - Governor (GV) - governing meridians. Those meridians are not strictly connected with defined organs although they include many points used in the treatment of internal organs. The Ryodoraku values are affected by the following; the actual health state of the patient, the season of the year, the region where the patient lives and the family situation of the patient, the body temperature of the patients and the atmospheric temperature. Also clear differences between the measurements of the left and right side

of the body do not have to be caused by the internal diseases and may simply result from disturbances of the superficial autonomic nerves, such as neuralgia or disturbances of the sensitivity of a certain side of the body. High values could also result from a small wound or from rubbing the skin. In case of particularly significant differences in the Ryodoraku values between the left and right side of the body, the lower value is considered to be more likely (Table 2). The value of stimulation and number of therapeutic points should be increased in the successive repetitions. Also there is a rule that when the patient is younger and his body weight smaller the doses are smaller and more exactly established (Hyodo, 1979). It should be also stressed that the skin electrical conductivity also depends on the health state of the sympathetic system.

**Table 2.** The Ryodoraku symptoms in man (*Hyodo, 1975*)

Meridian	Specific organs and tissues	High electrical conductivity		Low electrical conductivity	
		General symptoms	Secondary general symptoms	General symptoms	Secondary general symptoms
H1 (lungs)	nose, lungs, skin	shoulder and back, stiffness, hot flushes, anal disorders, asthma	palpitations, shoulder pains, back pains, tonsillitis, cough	cold and numbness of limbs, vertigo, respiratory disturbances	skin disorders, dry throat, shoulder pains, back pains, cough
H2 (pericardium)	heart	shoulder stiffness	cardiac disorder, pain in the arm, constipations	palpitations, headaches	speech disturbances, chest discomfort, hot palms
H3 (heart)	tongue, armpit	the feeling of having full stomach, constipations, pains in the shoulder	limb heaviness, dry throat, cardiac disorders, cold hands, hot palms, fever, speech disorder	palpitations, nausea	lower chest organ diseases, speech disturbances, hot palms, diarrhoea, anxiety
H4 (small intestine)	ear	headaches, weakness in limbs, hypogastrium organ diseases, shoulder pains, rheumatism	constipations, neck diseases, mouth cavity diseases, fever	headaches, hypogastrium organ diseases	ear buzzing, hearing disturbances, cold limbs, diarrhoea
H5 (triple heater)	lymph, ear	dysuria, ear buzzing	ear buzzing, face blush and sweat, fever, exhaustion, throat swelling	respiratory disturbances, nausea	abdominal cavity organ diseases, discoloration, moderate fever
H6 (large intestine)	mouth (teeth), skin, nose, shoulder	shoulder stiffness	toothache, anal disorder, headaches, stomachaches, vertigo, the feeling of tiredness in the palms and fingers, skin disorders	shoulder stiffness	intestinal and skin disorders, diarrhoea, asthma, the feeling of discomfort and anxiety, dry throat
F1 (spleen-pancreas)	stomach, intercoastal tissue, brain	"lax stomach", joint diseases	nose diseases, the feeling of fullness in the abdominal cavity, nausea, chest discomfort, food poisonings, diarrhoea, constipations	"lax stomach", skin disorders, constipations	intestinal disorders, nausea, the feeling of fullness in the abdominal cavity, anorexia
F2 (liver)	sex organs, intercoastal tissue	lumbago, insomnia, vertigo, dysmenorrhoea	chest pains, eye diseases, sex organ diseases, general discomfort, dysmenorrhoea	cold legs, vertigo, impotency, mental depression	dysuria, sight disorders, muscular weakness, hernia, intercoastal neuralgia

F3 (kidneys)	adrenal gland, ear	malaise, nausea	disorders of the sex organs, hot legs, potency disorder	general weakness, cold legs, impotency	intellectual dullness, ear buzzing, intestinal disorders
F4 (urinary bladder)	eye, nose, brain, mucous membrane	neck stiffness, weakness in lower limbs	back diseases, headaches, lachrimation, eye pains or diseases, bleeding from the nose, brain diseases, epilepsy	muscular stiffness of the back of the neck, heaviness and weakness of limbs, back diseases	ischialgia, anal disorders, brain diseases, epilepsy
F5 (gallbladder)	eye, head	bitter taste, throat diseases	anorexia, irritation (agitation), fever and shivers	eye diseases, vertigo	vertigo, weakness in limbs, ataxia, blood pressure disorders, xanthopsia
F6 (stomach)	mouth cavity (teeth), nose, upper eyelid, mammary glands	muscle stiffness of the back of the neck, joint deformations	mastitis, xerostomia, anorexia, fever	shoulder stiffness, constipations, the feeling of fullness in the stomach, mental depression	increased peristaltic movement, xerostomia, stomachaches, face swelling, shivers, diarrhoea

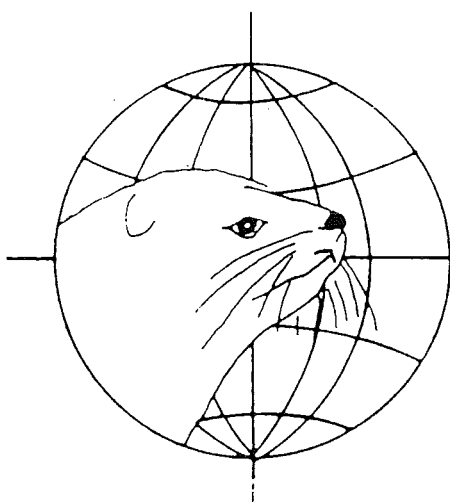
Stimulation aiming at the stimulation of the sympathetic system causes the increased electrical conductivity and the blocking of that system significantly reduces that conductivity (Hyodo, 1979).

The Y. Nakatani diagnostic method has found its way into human medicine. Thus, it seems reasonable to adapt the method for the needs of veterinary medicine and possibly, in the future, to the needs of breeding practice.

The method has been used for the evaluation of the functional state of the organism in both healthy and diseased foxes. These investigations are presented in the second part of the paper.

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**IFASA**

*Original Report*

## Measurement of skin electrical conductivity at acupuncture points in healthy and diseased polar foxes

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### Summary

The investigations aimed at measuring the skin electrical conductivity at the representative acupuncture points (RMP) with the Reodoraku method in healthy and diseased male and female polar foxes on the right and left side of the body.

The investigations of electrical conductivity at the acupuncture points (RMP) measured with the Reodoraku method on one side of the body may be considered as representative. The results of those measurements are similar to the mean value for two measurements taken on both sides of the body.

Sex does not significantly affect the value of electrical conductivity at the Reodoraku points.

On the basis of the obtained results the mean range of electrical conductivity (RMP) was determined for foxes clinically healthy and those having pathological symptoms on the skin.

It seems the method of measuring the skin electrical conductivity (RMP) with the Reodoraku at the acupuncture points could be of great diagnostic

and therapeutic significance for determining the functional state of healthy and diseased animals.

### Introduction

The present work is the continuation of investigations carried out by the author in 1988, 1989 and 1990.

The investigations concerned the skin electrical conductivity measurement - REPP (Reactive Electric Permeable Points) at the acupuncture points responsible for immunity in young and mature, healthy and diseased foxes.

The investigations described in the present paper aimed at taking the measurements of the skin electrical conductivity at the representative acupuncture points (RMP) with the Reodoraku method in healthy and diseased mature polar foxes.

The experiments were performed to reveal the existence of the dependence between the obtained results and the functional state of internal organs in males and females and the comparison was made between the results of measurements (RMP) taken



on the left and right side of the body of healthy and diseased foxes (Hyodo, 1955; Hyodo 1975; Hyodo 1979; Nakatani, Hyodo, 1985).

**Material and methods**

A series of 2 experiments was carried out from 1988 to 1991 on a farm of common and polar foxes at Duchnice near Pruszkow. Blue polar foxes (*Alopex lagopus* L.) comprised the experimental material.

The first experimental group comprised 10 mature polar foxes with purulent changes on the skin. The

control group included 10 clinically healthy, mature polar foxes. The second experimental group comprised 8 female polar foxes, healthy and mature at the time between heats. The control group included 8 males at the time between copulation periods, which were also healthy and mature.

The measurements in both experiments were taken with the help of the RAComp II apparatus by Soft Electronics from Szczecin, in co-operation with a personal computer ZX Spectrum +. An indifferent electrode was attached to the animal tail thus closing the electric circuit and the acupuncture point was localized using the active electrode.

**Table 1.** Measurement of electric conductivity (RMP) at the Ryodoraku points in mature and diseased foxes (in  $\mu A$ )

Point	Group of animals - mature foxes						Arith- metic coeffici- ent
	Healthy			Diseased			
	$\bar{x}$	S	V (%)	$\bar{x}$	S	V (%)	
H1	71.0	9.3	13.00	117.8	10.35	8.79	1.66*
H2	47.1	3.38	7.18	110.6	2.70	2.44	2.35*
H3	67.1	4.56	6.79	95.4	3.21	3.36	1.42
H4	56.8	5.05	8.89	58.6	4.04	6.89	1.03
H5	44.2	3.13	7.01	117.7	5.63	4.68	2.69*
H6	70.1	8.57	12.22	55.8	4.32	7.74	0.79
F1	40.2	8.16	20.3	86.6	1.95	2.25	2.15*
F2	65.3	6.57	10.06	66.0	4.30	6.51	1.01
F3	79.5	14.35	18.5	41.2	6.94	16.84	0.52
F4	48.9	3.31	6.77	58.4	3.29	5.63	1.19
F5	73.9	6.89	9.32	57.0	0.71	1.24	0.77
F6	49.5	5.02	10.14	75.0	3.81	5.08	1.51*

$\bar{x}$  - mean value of the electrical conductivity potentials

S - standard deviation

V - variability coefficient

\* - with a number means a highly significant statistical difference

The arithmetic coefficient which equals 1 means the lack of statistical significance, 0.5 or 1.5 means 50% difference between the obtained results over 1.5 or below 0.5 - the difference is accepted as significant.

The result of electrical conductivity could be read at the monitor screen connected with the micro-computer-interface system within 1-2 sec from the beginning of the measurement. The measurements were taken using direct current of 12V voltage and the short-circuit current of 200  $\mu$ A.

In the experiment the measurement of electrical conductivity was taken at the representative measuring points RMP with the Reodoraku method; H1-H6 and F1-F6.

The obtained results were evaluated statistically using t-Student (Gosset) test for normal distribu-

tion at two levels of significance;  $\alpha = 0.05$  and  $\alpha = 0.01$  (Wojcik, 1984).

### Results and discussion

The following results were obtained measurements taken at the RMP - the representative measuring points - with the Ryodoraku method showed statistically significant differences between the groups of healthy and diseased foxes at points H1, H2, H5, F1, F3, and F6 (Table 1). It means that the Ryodoraku method allows checking of the functional state of particular organs or systems.

**Table 2.** The measurement of electrical conductivity (RMP) at the Ryodoraku points in the groups of males and female mature and healthy foxes

Point	Group of animals - mature foxes						
	Males			Females			Arithmetic coefficient
	$\bar{x}$	S	V (%)	$\bar{x}$	S	V (%)	
H1	62	8.37	13.50	57	28.63	50.23	0.92
H2	64	12.94	20.22	60	29.15	48.58	0.94
H3	67	14.83	22.13	57	24.39	42.79	0.85
H4	64	34.35	53.67	59	31.70	53.73	0.92
H5	61	26.08	42.75	62	38.99	62.89	1.02
H6	60	27.39	45.65	62	34.93	56.34	1.03
F1	66	23.02	34.87	60	21.21	35.35	0.91
F2	75	23.45	31.27	66	26.08	39.51	0.88
F3	77	25.39	32.97	82	38.99	47.54	1.06
F4	75	27.39	36.52	72	29.49	40.96	0.96
F5	76	25.35	33.35	79	30.90	39.11	1.04
F6	76	18.16	23.89	82	33.47	40.82	1.08

$$\bar{x} = 68.58$$

$$\bar{x} = 66.50$$

$\bar{x}$  - mean value of the electrical conductivity potentials

S - standard deviation

V - variability coefficient

\* - mean value obtained from all the mean values

The arithmetic coefficient which equals 1 means the lack of statistical significance, 0.5 or 1.5 means 50% difference between the obtained results over 1.5 or below 0.5 - the difference is accepted as significant.

Since the group of diseased animals comprised mainly bitten foxes, foxes with skin diseases or with other clinical symptoms, those symptoms affected electrical conductivity at the representative measuring points (RMP) because; meridian H1 is responsible for the functional state of lungs and skin; H2 - for heart and manifests itself in case of other diseases, e.g. pneumonia; H5 - its pathological range reveals itself in the states of organism weakness and fever; the appearance of pathological value F1 can be connected with all types of food poisonings; the F3 symptom is general ill-being and nausea and F6 lack of appetite and fever. The range of average measurements at the RMP in healthy foxes goes from 40.2 to 79.5  $\mu\text{A}$  and in diseased foxes from 41.2 to 117.8  $\mu\text{A}$ . However, it should be stressed that on the basis of these investigations the objective of establishing the type of pathological state is not fully possible. Still, the method allows a quicker and more relevant choice of therapeutic agents and instrumental techniques (Table 1).

The results obtained in the next experiment allow the assumption that there are no significant differences in the values of electrical conductivity potentials measured at the RMP points between males in the period between copulations and females in the period between heats. However, a high variability coefficient points to a number of animals in the examined group as being too small and high values of the standard deviation to a large variability of obtained results which most probably resulted from a greater excitement of some animals at the time of examination (Table 2).

It seems that the comparative results of experiments I and II can be used for determining the doses of acupuncture stimulation for diseased animals. They also have great diagnostic value.

The obtained results of electrical conductivity measured at the points responsible for immunity and at Ryodoraku points in healthy and diseased foxes confirm the opinion that it is possible to separate the, so-called, "physiological" and "pathological channel".

In view of the lack of material in the accessible literature presenting the above problem in animals it was impossible to discuss the results of our own investigations.

### Conclusions

1. The measurements of electrical conductivity at the acupuncture points using the Ryodoraku method performed on one side of the body can be accepted as representative. The results of those measurements are similar to the mean values obtained from the values of two measurements taken on both sides of the body.
2. Sex does not significantly affect the values of electrical conductivity at the Ryodoraku points.
3. On the basis of the obtained results the mean range of electrical conductivity (RMP) was determined in clinically healthy animals and in animals with pathological lesions on the skin.
4. It seems that the method of the electrical conductivity measurement (RMP) could be of a great therapeutic value in the future for determining the functional state of organism of healthy and diseased animals.

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### Improvement of ELISA in diagnosis of mink aleutian disease

Zhao GuangYing, Mei Quanlin, Zhao Shuqin

The fundamental method in controlling mink aleutian disease (MAD) is making a correct diagnosis. Though there were many diagnosis methods, such as IA, CIEP and so on, the deficiencies were of non-specialization, low detection percentage and expending large volumes of Ag. A new kind of diagnosis by MAD (PPA-ELISA) was selected.

In mink the special characteristics of MAD, on the basis of PPA-ELISA (staphylococcus protein A linked horseradish peroxidase-ELISA), by selecting, studying and applying a set of improvements had been made. Polystyrene reaction plates were steeped in 1/10.000 tan-liquor for 120h to be good for the adsorption of Ag. The part uncovered by Ag at wells in the reaction plate was sealed with 1% calf serum solution at 37°C for 3 h to prevent unspecialized absorption by IgG in the mink serum quarantined. After adding the serum, the time of wash must be longer or more often than usual (3 min x 3 times) to clear away the unspecialized adsorption of IgG. It is better that 0.02M, PH7.4 Tris-HCL-Tween-20 is used as wash than 0.02M, PH7.4 PBS-Tween-20, the P/N is also greater. Be careful in cleaning the end of the micropipette and replacing it in time and not touching the reaction plate, to avoid mixing the contents of the holes with each other. The reaction result must be observed all the times after adding the substrate. The reaction must be stopped at once when a positive result is obvious.

Making use of improved PPA-ELISA to diagnose MAD, has many advantages, such as specialization, sensitivity, economy and convenience. Expended Ag and serum (Ab) Volume by improved PPA-ELISA was as little as 1/500-1/1000 and 1/200 of that by CIEP. This technique can be applied a large number of mink.

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### Mycological survey from coats of red foxes in Italy

F. Mancianti, R. Papini, A. Poli

One hundred nine free-ranging red foxes (*Vulpes vulpes* L.) were examined for dermatophytes and keratinophilic-related fungi by hairbrushing technique. The fungi isolated were: 3 strains of *Trichophyton mentagrophytes*, 1 with its perfect state *Arthroderma benhamiae*, 3 of *Trichophyton terrestris*, 5 of *Chrysosporium keratinophilum*, 1 of *Chrysosporium tropicum*, 1 of *Chrysosporium asperatum*, 2 of *Microsporum gypseum*; *Microsporum canis* was also isolated from the hair of 3 animals. The role of foxes in the spread of pathogenic and saprophytic fungi is discussed.

*J. Mycol. Méd.* 3: 109-110, 1993. 9 refs. Authors' summary.

### Results of screening for bacterial diseases on large-scale chinchilla (*Chinchilla laniger*) farms

S. Novak, D. Rutkay, I. Solar

At a large-scale farm of imported chinchillas (*Chinchilla laniger*) fed a special mash with the addition of a dried mixture of herbs, granules and apples as a stomachic a first sudden outbreak of losses appeared during the autumn. The main clinical symptoms were anorexia, haemorrhagic diarrhoea and/or constipation. Post mortem findings consisted mainly of heavy catarrhal enteritis and colitis, respectively. At the acute course of the disease, which ensued next spring, heavy diarrhoea alternated with constipation; occasionally cases of incoordinant movements and abortions of pregnant females were recorded.

Bacteriological examination of 195 submitted carcasses of 1500 animals of the farm revealed in 44 cases *Salmonella* enteritidis and in 19 cases *Listeria monocytogenes*, mainly 1/2 serovar, but serovar 4 in two cases. Occasionally strains of *Yersinia enterocolitica* and *Pseudomonas aeruginosa* were isolated. With no satisfactory results using Imequil

as a remedy, an introduction of prepared autovaccine completely stopped the further appearance of disease.

The outbreaks of gastrointestinal illness in the chinchillas in the spring and autumn, respectively, were considered to be conditioned by climatic changes combined with feeding faults, which led to weakening of the animals and consequent growth of pathogenic bacteria in their gastrointestinal tracts.

*Slovensky Veterinarsky Casopis*, 19 (1): 19-21, 1994. In SLOV, Su. ENGL. 6 refs. Authors' summary.

#### **Susceptibility of streptococcus hemolyticus causing mastitis in coypus to Chinese and Western medicine**

Zhang Jidong, Feng Minshan, Li Peiguo

Four strains of  $\beta$ -hemolytic streptococcus obtained from the culture fresh milk from a female coypus suffering from mastitis were used to test their susceptibility to Chinese and Western medicine. The results showed that among 18 Chinese medicines, only *Radix scutellariae*, *Radix isatidis*, *Flos loricerae* and *Herbavilolene* had bacteriostatic effect, with small differences among the strains. Six kinds of bacteriostatic medicine such as cephalosporin, gentamicin and ampicillin etc. had obviously bacteriostatic effects, but varied according to strain.

*Heilongjiang Journal of Animal Science and Veterinary Medicine (China)*, No. 9: 34-35, 1992. In CHIN. 2 tables. Authors' abstract.

#### **Distemper in raccoons**

Alain Laperle

Thirty raccoons, from the island of Montreal, were necropsied because of an increased mortality in the population and observed changes in behaviour. Submitted animals were weak and presented ocular discharge. Many appeared to be blind.

At necropsy, except for the purulent conjunctivitis, lesions were confined to the lungs. Pulmonary parenchyma was red, non-collapsed with a rubbery texture. Cranial pulmonary lobes were noted to be consolidated in some carcasses.

Microscopic examination revealed a catarrhal pneumonia, sometimes complicated with a purulent bronchopneumonia associated with presence of bacteria. Acidophilic inclusion bodies, mainly intracytoplasmic but also intranuclear, were observed in the epithelium of numerous organs. These inclusion bodies were prominent in the epithelium of bronchi and stomach, and in the uroepithelium of the renal pelvis and bladder.

*Medicin Veterinaire du Quebec* 23 (2): 83-85, 1993. In FREN, Su. ENGL. 5 figs., 5 refs. Author's abstract.

#### **Case reports on cardiomyopathy in the domestic ferret, *Mustela putorius furo***

Rebecca M. Atkinson

Five ferrets (from a total of 23 referral cases) with dilatative cardiomyopathy were evaluated at the Ontario Veterinary College from 1991 to 1992. Presenting complaints included sneezing, coughing, and chronic weight loss despite a good appetite.

Clinical signs presented were dyspnea, tachypnea, tachycardia, muffled heart and lung sounds, and occasional ascites. Radiographs revealed cardiomegaly, pleural effusion, pulmonary edema, and in some cases, splenomegaly, ascites, and hepatomegaly. Electrocardiography (ECG) showed premature ventricular contractions, tachycardia, and sinus arrhythmia. Echocardiography revealed enlarged heart chambers and decreased cardiac output. Therapy included digitalization, diuretics, enalapril, vasodilators, and decreased dietary sodium intake. Prognosis was guarded with survival times of three to five months from the onset of clinical signs.

*Journal of Small Exotic Animal Medicine* 2 (2): 75-78, 1992. 1 table, 3 figs., 9 refs. Author's abstract.

### **Isolation and identification of mink enteric coronavirus**

*Han Hiumin, Liu Weiquan, Yang Shenghua*

Two strains of coronavirus were isolated from 6 fecal samples of infected mink with mink lung cell line (ML) cultures. Its morphological features were visualized by electron microscopy: most enveloped particles are irregularly round with average diameters ranging from 80 to 160 nm. Petal-shaped surface projections protrude from envelopes. It is ether-sensitive and does not tolerate 37°C for 12 hours, but retains a certain viability at room temperature for 3 hours in a pH 3.0 medium. It was identified as mink enteric coronavirus. In an inoculation test, some of mink experimentally infected with the virus were sick and manifested diarrhea.

*Bulletin of Veterinary College of PLA (China), Vol. 12 (1): 65-67, 1992. In CHIN, Su. ENGL. 8 refs. Authors' abstract.*

### **An experimental infection of breeding foxes with *Microsporium canis*: treatment and immunoprophylaxis**

*Krystyna Wawrzkievicz, Janusz Wawrzkievicz, Zdzislaw Sadzikowski*

Investigations were carried out on 32 foxes aged approximately 2 months. The comparative studies on an experimental infection with *Microsporium canis* and *Trichophyton* spp revealed that in foxes infected with *M. canis* distinctive signs of the disease occurred at about 3 weeks after inoculation of the fungus. In silver foxes they were better expressed and lasted for 2-3 months and cleared 3-4 months after infection. In polar foxes ringworm was of a lesser course: clinical signs cleared within 2 months. In foxes infected with *Trichophyton mentagrophytes* var. *granulosum* the first clinical signs appeared as early as after 7 days, progressed to their maxima after 2-3 weeks and cleared at approximately 6 weeks. The administration of the vaccine Bovitrichovac II (inactivated *T. verrucosum* strain) proved to be ineffective in case of *M. canis* infections. In contrast it was effective in the

treatment of foxes infected with *T. mentagrophytes* var. *granulosum*. Four different vaccines were used for prophylactic purposes: a) Bovitrichovac II; b) an inactivated combined vaccine containing *T. verrucosum* and *T. mentagrophytes* strains; c) two variants of inactivated vaccines comprising *M. canis* strains. Bovitrichovac II and the combined vaccine protected foxes from *T. mentagrophytes* var. *granulosum* infection but not from *M. canis*. In contrast, specific vaccines appeared to be of good immunogenicity as they protected the animals from infection with *M. canis*. The skin test performed on foxes vaccinated for prophylactic purposes with *M. canis* vaccines (both variants) showed a positive response after the administration of allergen made of a *Trichophyton mentagrophytes* strain. The results point to the presence of some common antigenic fractions among *Microsporium* and *Trichophyton* strains that are active and stimulate allergic reactions. However, they do not seem to play any role in the cross-immunity. The findings indicate that there are some prospects for elaborating specific immunoprophylaxis against *M. canis* infection of cats and dogs.

*Medycyna Weterynaryjna 49 (12): 543-547, 1993. In POLH, Su. ENGL. 3 tables, 2 figs., 35 refs. Authors' summary.*

### **Listeriosis in breeding foxes**

*Janusz Wawrzkievicz, Barbara Majer-Dziedzic, Zdzislaw Sadzikowski*

A case of listeriosis in new-born foxes has been described. At necropsy a significant enlargement of the spleen was observed, from which a pathogen was isolated in a pure culture. On agar medium with sheep blood (5 per cent), tiny colonies with a wide zone of beta-haemolysis were noticed after 24 hours growth. On microscopic films gram-positive rods measuring 2 by 0.5 µm were found. The rods were distinctively mobile at 22°C. They produced catalase, fermented aesculine, d-arabitol, rhamnose, alpha-methyl-D-glucoside and alpha-xylose. D-xylose, glucose-1-phosphate, D-tagose and alpha-mannosidase were not fermented. The strains proved to be pathogenic for mice and guinea-pigs. A

severe conjunctivitis was observed in guinea-pigs which were administered a suspension of the bacteria intraconjunctively. In the exudation, gram-positive rods were found (Anton's test - positive). The examinations allowed the classification of the isolated bacteria as *Listeria monocytogenes*

*Medycyna Wet.* 50 (10): 480-482. In POLH, Su. ENGL. 5 figs., 18 refs. Authors' summary.

### **Mink disease outbreak caused by *A. Hydrophila***

Li Wenyu

On a farm raising 470 mink, the animals were suddenly found to bleed from the noses and to die suddenly. The systemic tissue organs showed signs of infectious disease with septicemia and 241 died in 12 days. By epidemic investigation, microscopic examination of smears made from liver, heart, spleen, and lungs and through the isolation, cultivation and biochemical tests of isolated bacteria and infection with the bacteria into white mice, a diagnosis was made that the disease was caused by *A. hydrophila*. The effect of treatment with appropriate medicine is good.

*Chinese J. of Vet. Med. (China)*, 19, 1: 19-20, 1993. In Chinese. Author's summary.

### **Plasmacytosis control 1994**

Erik Smeds

The disease situation in Finland for 1993 is reported; 220,000 blood samples were tested (18% fewer than in 1992). The number of breeding animals was 18% lower, and the number of farms 14% lower. There were about 250 plasmacytosis-free farms (35% of the total number of farms), representing 32% of all the breeding animals. The cost of the blood test for each animal was 2.00 FMK, and 1.00 FMK for subsequent tests in the same year. The registration categories (A-E) for the disease are defined.

*Finsk Pålstidskrift* 28, 1/2: 23, 1994. In SWED. 1 fig. CAB-abstract.

### **The health status of furbearing animals 1993**

Kirsti Pekkanen

Distemper was diagnosed on 4 farms in Finland during the year (in 2 mink, one fox and one raccoon dog). The situation in wild animals is described briefly. Parvovirus enteritis occurred in raccoon dogs on 2 farms, mange in foxes on 5 farms, Nosema infection in blue fox cubs on 3 farms, *Pseudomonas aeruginosa* infection (haemorrhagic pneumonia) in blue fox breeding females on 3 farms, and heart disorders of unknown aetiology in blue foxes on 8 farms (on one of these farms 70% of the cubs died). Vaccination is discussed in relation to specific diseases.

*Finsk Pålstidskrift* 28, 1/2: 20-21, 1994. In SWED. CAB-abstract.

### **Epizootic pneumonia in nutria**

P. Martino, N. Stanchi

This report highlights current knowledge regarding the aetiology, diagnosis and management of nutria (*Myocastor coypus* Molina 1792) with spontaneous infectious pneumonia. Bacteriological evidence supports the view that *Streptococcus zooepidemicus* could be the specific pathogen, although other bacteria were also isolated. Attempts at virus isolation were unsuccessful. Pneumonia has rapidly become established as one of the major, life-threatening bacterial diseases, ranking in importance with gastroenteritis infections.

*J. Vet. Med. B.* 41, pp 561-566, 1994. 21 refs. Authors' summary.

### **Chronic toxicity of fumonisins from *Fusarium moniliforme* culture material (M-1325) to mink**

J.C. Restum, S.J. Bursian, M. Millerick, J.A. Render, A.H. Merrill, Jr., E. Wang, G.E. Rottinghaus, R.J. Aulerich

Adult female mink (*Mustela vison*) were fed a diet that contained *Fusarium moniliforme* culture ma

terial that provided dietary concentrations of 89 ppm fumonisin B<sub>1</sub>, 21 ppm fumonisin B<sub>2</sub>, and 8 ppm fumonisin B<sub>3</sub> for 87 days. During the trial, there was mild lethargy in the mink fed fumonisins, but no other clinical signs or differences in feed consumption (measured during the first two weeks), body weights, or survivability were observed between the fumonisin-treated and control mink. Several hematological parameters (mean corpuscular hemoglobin concentration, plasma total solids, and lymphocyte concentration) and serum chemical concentrations (globulin, phosphorus, potassium, blood urea nitrogen, creatinine, bilirubin, and cholesterol) and activities (alkaline phosphatase, alanine aminotransferase, amylase, and aspartate aminotransferase) were greater in the mink fed fumonisins than in the controls. Serum

albumin/globulin and sodium/potassium ratios and chloride concentrations were lower in the fumonisin-fed mink than in the controls. The concentrations of free sphinganine and the ratio of free sphinganine to free sphingosine in the liver and kidneys of the fumonisin-treated mink were greater than in the control mink. No histopathologic alterations were associated with fumonisin treatment.

These results indicate that long-term dietary exposure to *F. moniliforme* culture material containing 118 ppm total fumonisins is not lethal to adult mink, but can produce adverse physiological effects in the animals.

*Arch. Environ. Contam. Toxicol.* 29, pp 545-550, 1995. 3 tables, 38 refs. Authors' summary.



GOOD SKIING





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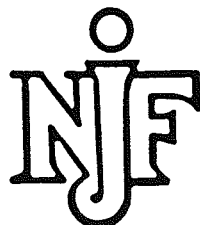
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UTREDNINGAR - RAPPORTER

## Ethics and fur production

*Peter Sandøe*

To many people fur production is perceived as being unethical. In the presentation an attempt will be made to formulate the different kinds of concerns that seem to underlie this perception. It will be argued that as such fur production is no less ethical than any other kind of animal production. However, some of the ways animals are treated in fur farms may give rise to justified concerns about the welfare of the animals. These concerns are discussed in the light of a recent report by the Norwegian Ethical Council for Farm Animals. Finally, it will be discussed how the fur industry should handle the "ethics-issue".

*NJF report no. 106, 1996. Only abstract received.*

## Simulation of mink breeding programme

*E. Børsting*

A simulation model for mink breeding is built on the experience from the broiler breeding plan at ScanBrid Int. This plan is similar to a mink breeding programme, and the special mink model developed for a PC is a modification of the poultry model. The mink model is called MINKSIM, and it can simulate selection in a mink population for litter size, pelt quality, and body weight.

Population parameters describe the mink type to work with, selection parameters control how the selection is done, and the user controls the selection by filling in the parameters in a start-up input screen.

The simulation method is stochastic, therefore the results have to be based on replicate lines, and the results are presented as average progress for all lines.

The results from the model are: average inbreeding per year and line, and average progress in litter size, pelt quality, and body weight.

*NJF report no. 106, 1996, 10 pp. In DANH, 2 tables, 4 figs.*

## The effect of three different housing systems on the behaviour, reproduction, physiology, and production parameters in farmed silver foxes (*Vulpes vulpes*)

*V. Pedersen, L.L. Jeppesen, K. Skovgaard*

In a five-year project (to be completed in 1996) the effects of three different housing systems on various behavioural, physiological and production-related parameters are examined in 136 silver foxes and 136 blue foxes. This presentation concerns preliminary results on the silver foxes, only. System 1 is a traditional barren wire mesh cage, measuring 1x1.2x0.75 m(LxDxH). System 2 is a double cage, measuring 2x1.2x0.75 m, which has 2 platforms, a quarter of solid floor, and a whole-year nest box mounted on the roof of the cage. System 3 is an enclosure measuring 2x2.4x2 m with a tile floor, 4 platforms and a whole-year nest box. The foxes were introduced to these systems in the autumn of 1993.

One year after introduction to the systems, system 2 foxes were more active in a novel environment compared to system 1 foxes ( $P<0.05$ ). System 3 foxes showed more exploration compared to both system 1 and 2 foxes ( $P<0.05$ ), indicating less fear when exposed to novel surroundings than the system 3 foxes. The physiological measures indicated a lower stress level in system 2 foxes due to significantly lower base levels of cortisol in these compared to both system 1 and 3 foxes (system 1=91.6 nmol/l, system 2=64.5 nmol/l, system 3=80.6 nmol/l,  $P<0.05$ ). A better reproductive success was found in system 2 foxes which gave birth to more cubs compared to both system 1 and 3 foxes ( $P<0.01$ ). In system 3 some cubs were lost due to poor hygiene (mixture of faeces, sand, and feed). Two years after the introduction, no differences in litter size at birth were revealed, but system 2 foxes weaned less cubs compared to both system 1 and 3 foxes ( $P<0.01$ ). This was probably due to social stress between new and old neighbours in system 2, but this will be examined thoroughly.

Cleaning time in system 1 was the shortest with 23.4 min per cleaning, system 2 took longer time to clean compared to system 1 (52.9 min) and system 3 took the longest time to clean compared both to system 1 and 2 (101.8 min) ( $P<0.0001$ ).

Regarding pelt parameters, system 2 and 3 resulted in a poor purity of the pelts compared to system 1 ( $P < 0.0001$ ), but system 3 foxes showed a better overall quality of the pelts ( $P < 0.0001$ ). No differences in size of the pelts were revealed ( $P > 0.1$ ).

From a welfare point of view, the results indicated that system 2 might be a good alternative to the traditional cage system (system 1), and system 3 would be the second best alternative for silver foxes. However, we need to complete the project in order to make a firm conclusion on that aspect.

*NJF Report No. 106, 1996, 7 pp. In DANH, 4 tables, 3 refs. Authors' summary.*

### **The preference for different types of floor in silver foxes and blue foxes**

*K. Skovgaard, V. Pedersen, L.L. Jeppesen*

In welfare, research improvements of the housing conditions have a high priority. Different kinds of equipment in the cage have been examined which has led to the recommendation of access to an observation platform for all foxes. But the type of floor may be of equal importance. To examine this, two preference tests were arranged: 1) the preference for either a solid floor or a wire mesh floor and 2) the preference for three different kinds of wire mesh floor (plastic-covered wire, 1 x 1 inch stainless wire, 1 x 1.5 inch electroplated wire).

1) The test was carried out on both adults and cubs of silver and blue foxes. The data were based on 24 h video recordings. The results showed that adult silver and blue foxes distributed their time equally on solid floor and on wire mesh floor. Cubs tended to prefer the solid floor while young, but this tendency was obviated as the cubs grew older. The tendency obviated at an earlier age for the blue fox cubs than for the silver fox cubs and this could be caused by the soiling of the solid floor in the blue fox cages. The silver fox cubs kept their solid floor relatively clean throughout the experiment. The results also showed that early experience with a given type of floor was reflected in the foxes' preference as adults, so that cubs born on solid floor tended to choose the solid floor

more often as adults than cubs born on wire mesh floor and vice versa.

2) This test was carried out on adult blue fox males. The data were based both on daytime scan-samplings collected manually and on 24 h video recordings. The results of the daytime scan samplings showed that the foxes were observed most frequently on the plastic-covered wire, less frequently on the 1 x 1 inch stainless wire, and least frequently on the 1 x 1.5 inch electroplated wire. The video recordings showed no difference in the distribution on the three types of wire mesh floor.

In the first study the conclusion could be that wire mesh floor is not aversive to neither silver nor blue foxes. The foxes showed no clear preference for a solid or a wire mesh floor, but early experience seemed to influence the later choice of stay, especially for the blue foxes. Soiling could lead to an avoidance of the solid floor, but this was only a problem for the blue foxes.

In the second study, the conclusion was that adult blue fox males showed no clear preference for a given type of wire mesh since no concordance between the daytime scan samplings and the video recordings was revealed. The difference in frequency between the three types of wire mesh in the daytime scan samplings is most likely due to "statistic sensitivity" rather than a true preference. But in order to fully understand the foxes' preference for flooring in the cage it is necessary to involve e.g. the effect of early experience in more detail among other aspects.

*NJF-report no. 106, 1996, 7 pp. In DANH, 1 table, 4 refs.*

### **Key features of housing design in farm foxes**

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

When studying housing design of farm animals, two opposite approaches can be and have been used. "The back to nature" approach uses nature as a reference. Trial and error method creates a new housing environment by successive modifications of an initial idea. A combination of both ap-

proaches implies that we first define a need that is derived from the behaviour of the animal in nature and then construct an environment that meets this particular need.

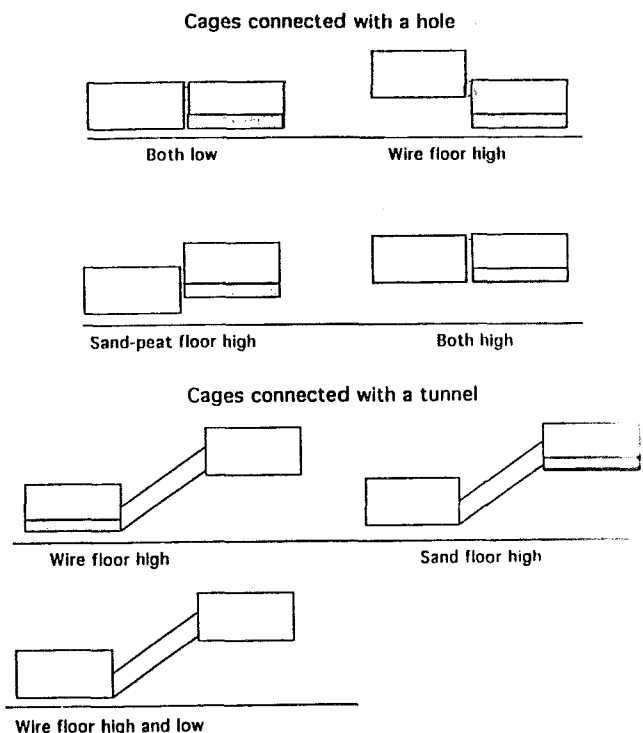
For an example, the European convention defines four behavioural needs for foxes, i.e. a need for rest and observing on a higher place, a need to lie on a solid floor and a need to conceal themselves from people and other animals. And the recommended construction that meets these needs is a resting platform with solid floor and walls placed as high as possible in the cage. However, both long-term follow-up studies under practical farm conditions and short-term preference tests have shown that: 1) either fox species do not have a clear preference for solid floor compared to wire mesh floor, 2) they do not like walls, 3) when disturbed they stay on or jump onto an open platform more often than they stay on or jump onto a platform with walls, and 4) although they use platforms for resting they prefer the wire mesh floor for that purpose. Thus either the foxes do not fit the initial idea or the constructions do not meet the needs of foxes.

Similar unexpected results were found regarding all-year nest boxes. Silver foxes used a floor box as much as a top-mounted box. However, in the former case they spent their time on the open roof of box, while in the latter case they were inside. Opening of a front wall of the box changed its properties to such an extent that silver foxes lost their interest in it. This aversion was long lasting and did not disappear although the front wall was closed again.

In a preference test between earthen and wire mesh floors the result depends on the method the alternatives are connected to each other, temperature and other features of the environment. If the cage pairs compared with were connected with a simple opening, the silver foxes changed the cage half up to 250 times a day. However, when the same cages were connected with a long 1.5 m) wire mesh tunnel, the number of cage exchanges exceeded in an extreme situation 500 per hour.

These examples demonstrate that in many cases even a small modification in an environment may cause crucial changes in foxes' behaviour whereas

some major modifications can be without any effect. Obviously some key features of the environment affect the animals' choices more than other features. In many cases these features may be surprising or unexpected. However, it is important to find these key features and construct a housing design of a set of key features relevant to the animal rather than to man.



**Fig. 1.** Experimental set-up in the two experimental series in which preference for wire-mesh floor was balanced against preference for elevated floor level in silver foxes.

*NJF report no. 106, 1996, 15 pp. 7 figs., 25 refs. Authors' abstract.*

#### **Foxes do not like nontransparent walls**

*Jaakko Mononen, Mikko Harri, Teppo Rekilä, Leena Ahola*

Preference tests are useful first tool in assessing those features of the housing environment that farm animals regard attractive or aversive. In our earlier studies, we have discovered that a preference for any furnishing farmed silver and blue foxes are

provided with, may be affected by the side effects that these structures have on the view from the cage. Foxes seem to avoid resting at a site from which the view is obstructed. In the present study, this hypothesis was tested.

Four adult silver foxes and four adult blue foxes were each provided with a double wire mesh cage. Both cage sections measured L115xW105xH70 cm.

The foxes had free access from one section to the other through an opening in the wire mesh wall between the sections. The use of the sections was recorded in four two-day periods: 1) both sections without nontransparent walls, 2) nontransparent walls in the left section, 3) nontransparent walls in the right section and 4) both sections without nontransparent walls. The three nontransparent walls were only 45 cm high, i.e. the foxes were able to

see over them (when sitting or standing). There was no nontransparent wall between the cage sections.

The preference for the cage without nontransparent walls as a resting site was almost exclusive in both species. The foxes also clearly preferred the cage without nontransparent walls during active behaviour. The aversion for the cage with the nontransparent walls endured to some extent although the walls were removed (see table 1).

It is concluded that the obstructed view is a key feature, usually an unintentional one, which should be taken into consideration when interpreting farmed foxes' preferences for cage furnishing.

*NJF-report no. 106, 1996. Only summary received. Authors' summary.*

**Table 1.** Percentage of active and passive time (mean±SD (median)) spent in the left cage section by silver foxes (n=4) and blue foxes (n=4). \*=Differs from 50% (p<0.05, paired t-test)

Period	Silver foxes		Blue foxes	
	Rest	Active	Rest	Active
No walls	37±39 (31)	50±13 (45)	73±31 (80)	57±12 (56)
Walls in left cage	7±8 (6)*	16±16 (15)*	16±31 (0)	29±9 (25)*
Walls in right cage	96±7 (100)*	85±15 (89)*	95±6 (97)*	72±6 (69)*
No walls	78±16 (78)*	46±6 (45)	92±12 (97)*	58±9 (60)

**Top box for farmed foxes: a hiding or an observation place**

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

Earlier results have shown that both farmed fox species prefer nest boxes placed high. Under these circumstances, opening of the front wall of the top box has been used as a method to familiarize animals to the presence of humans. On the other hand, earlier findings have also shown that neither blue nor silver foxes like resting platforms with walls, a construction that closely resembles the top box with its front wall open. In this study, the known preference of foxes for top-mounted nest boxes was weighed against their non-preference for clos-

ed platforms by opening and closing the front wall of the top box.

In January, nest boxes (46 cm x 46 cm x 36 cm plus a shorter anteroom) were mounted on roofs of cages of 8 silver fox and 8 blue fox vixens. Platforms (107 cm x 24 cm) were hung about 25 cm below the cage ceiling to serve as an entrance into the nest box. The use of the nest boxes was video recorded during four weeks (one 24-h period per animal during each week) and analyzed using the instantaneous sampling method with 5-min sampling intervals. The front wall of the boxes that was towards the corridor of the shed house was kept open during the 2nd and 4th weeks.

Silver foxes used the nest boxes on average 38±27

(median 42),  $3 \pm 2$  (3),  $6 \pm 7$  (5) and  $21 \pm 28$  % (4) of their resting time during 1st - 4th week, respectively ( $p < 0.05$ ). It is obvious that the foxes lost their interest in nest boxes following the opening of the front wall and never regained their interest again despite the wall was closed again during the third week. The silver foxes used the nest boxes more during the evening and night hours than during working hours ( $p < 0.01$ ). Generally blue foxes used the nest boxes far less than silver foxes: the percentages of use for the four periods being  $8 \pm 22$ ,  $12 \pm 34$ ,  $13 \pm 35$  and  $11 \pm 31$  % of resting time, respectively. Median values of the use for all the four periods were 0, which indicates a high inter-individual variance in the use. Four blue foxes did not use the boxes at all, whereas one individual spent most of its time inside the box. The behaviour of this one individual was not affected by the experimental design.

The present results show that the closed top box seems to have a different meaning for silver foxes than the open top box. The closed box may serve as a hiding place whereas the open box lacks this feature. Obviously opening of the front wall transformed the box to a platform with three walls which foxes do not like. It was, however, surprising that this aversion, once established, was long lasting and did not disappear after the wall was closed again. The present results also support the conclusion that silver and blue foxes differ from each other in regard to their behaviour towards the top boxes.

*NJF report no. 106, 1996, 8 pp. In SWED, 2 figs., 12 refs. Authors' summary.*

### **Development and possible causes of fur chewing in mink**

*Birthe Houbak, Steffen W. Hansen*

The objective of this investigation was to describe the temporal development of fur chewing in the neck and on the back and tail of mink. Furthermore, to study the effect of weaning age, growth conditions on the occurrence and development of fur chewing in mink kits.

The adult generation was selected and grouped partly on the basis of the extent and nature of fur chewing of own body, partly whether the cage mate did or did not show neck chewing. The kit generation included kits from the two groups mentioned and a randomly selected control group.

Fur chewing occurred when the kits were two months old irrespective of weaning time and growth conditions. Fur chewing in the neck was conditioned by the kits being housed two or more together. In kits kept in pairs, male and female, the frequency of fur chewing and aggression increased in September, probably due to the establishment of a social dominance relationship. After moulting in October, more kits had fur chews on hind body and tail when they were placed singly from the age of 6 weeks than when they were weaned in pairs at the age of 7 weeks or had grown up in families. Understimulation rather than weaning in mink, as an increased frequency of fur chewing was recorded when pairs of kits were separated from having been housed in pairs to being housed singly as adults. Furthermore, a reduction in fur chewing was recorded in females in the nursing period in comparison with males, but after the nursing period the frequency increased to the same level when the kits had been weaned. It seems possible to change the threshold value for the release of fur chewing through selection. Neck chewing may occur as a consequence of normal mink behaviour in connection with mating and aggressive interactions.

*NJF report no. 106, 1996, 8 pp. In DANH. Authors' abstract.*

### **Dutch fox farming field trial. Welfare of farmed blue foxes (*Alopex lagopus*)**

*Bert A.P. Urlings, Gerrit de Jonge*

This paper describes the outline of a field experiment that started in The Netherlands in April 1995 and that is intended to last for three years. In this experiment the latest knowledge concerning welfare, housing and socialization of blue foxes will be tested at farm level. The first breeding results are almost comparable to the breeding results of

the control animals. The farmers felt that housing and handling of the animals in these adapted nest boxes and socialization of the foxes provide them with additional instruments to control their foxes. The initial farmers' scepticism is changed into enthusiasm to implement these more welfare friendly production procedures in their normal farming practices.

*NJF report No. 106, 1996, 5pp. 1 table, 5 refs. Authors' abstract.*

### Development of a DNA-test for the Alaska-gene

*Dag Inge Våge*

Melanocyte stimulating hormone receptor (MSH-R) has a major function in the regulation of pigment synthesis within the melanocytes. Mutations in the gene encoding this receptor have a substantial effect on coat colour in several species. We have cloned and sequenced this gene in foxes (*Vulpes vulpes*), and several mutations have been detected. One mutation, 123 (Cys→Arg) has only been observed in animals that are carrying the Alaska-gene (cross foxes), while it has never been observed in animals that are non-carriers of the Alaska-gene (red or gold foxes). In total, 67 animals from 14 different litters have been tested. The 123 (Cys→Arg) mutation is localised within an area that is believed to constitute a part of the binding site of the receptor. This mutation may therefore explain the effect on coat colour that is observed in animals carrying the Alaska-gene. A DNA-test that differentiates between carriers and non-carriers of the 123 (Cys→Arg) mutation has been developed.

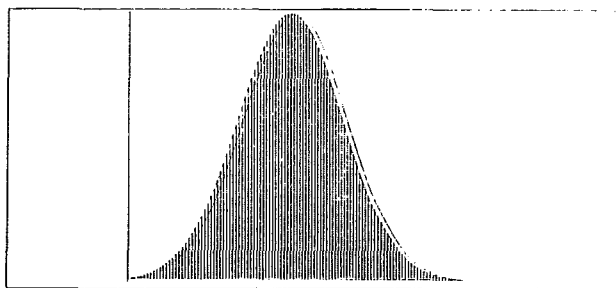
*NJF report No. 106, 1996, 5 pp. In NORG, 7 refs. Author's summary.*

### The effect of inbreeding on production traits in mink

*Peer Berg*

The effect of inbreeding on growth, pelt, and skin characteristics in mink has been estimated in a multiple trait animal model using a derivative-free REML algorithm. The model included random ef-

fects of additive genotype and common litter effects. Fixed effects included were year, sex, age, litter size, and a linear regression on the coefficient of inbreeding. Data stem from an experiment on Research Centre Foulum in illness with either alternating inbreeding-outbreeding or random mating respectively. Data from 1991-1994 are utilised, with the base population defined as parents of animals born in 1991. A total of 3998 animals from 640 litters was included in the analyses with number of observations varying between 2637 and 3700. Generally, inbreeding has negligible effect on production traits. The effect of a 10% increase in the coefficient of inbreeding was below or close to 1% of the mean for all traits, except skin quality with a decrease in the mean of 2.5%.



**Fig. 2.** Normal distributions with a difference of 0.1 standard deviation.

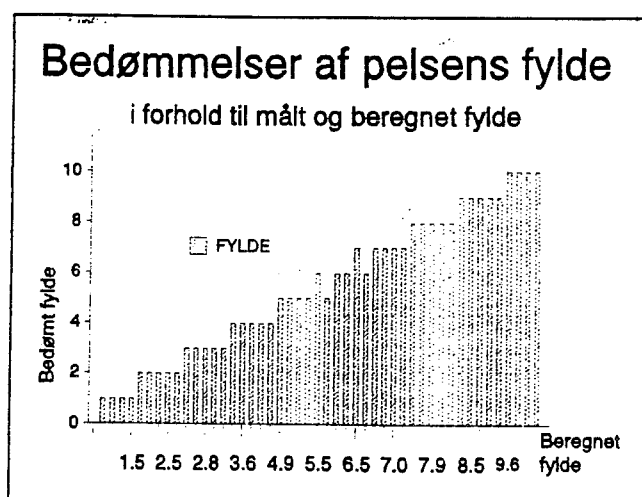
*NJF report No. 106, 1996, 7 pp. 3 tables, 3 figs., 6 refs. Author's summary.*

### Physical-mathematical methods can analyze properties of mink pelt

*Kaj Thorhauge*

New technology gives the opportunity to analyze mink pelt quantitatively (Thorhauge, 1994). The production from one breeding line can be analyzed and the results reported as a "farm profile" describing the distribution and quantity of the pelt properties, i.e. wool density and the length of wool and guard hairs. When comparing farm profiles, significant differences can be shown and specified. Likewise, different types of pelt for sale could be analyzed and trade descriptions made and compared.

Sensory evaluation and analysis considering mink pelt quality and density are compared to physical properties. Analysis with "principal components" show that quality depends on the relation between the lengths of wool and guard hairs as well as on the density of the wool hairs. Quality analyzed as a response surface to the physical properties confirms this. Furthermore, non-linear and exponential relations are found. It is indicated that elasticity has a linear relation to sensory evaluation of pelt density (bulk).



**Fig. 30.** Independent measurements and evaluations of the density of 47 scanblack pelts show a significant correlation.

*NJF report No. 106, 1996, 14 pp. In DANH, 4 tables, 30 figs. Author's summary.*

#### Morphological characterization of hair density and hair fibre composition in mink pelts selected on the basis of physical measurements of hair density

*Palle V. Rasmussen*

Based on physical measurements of hair density, 75 mink pelts (scanblack, males) were selected to represent high, medium, and low hair density ( $\text{mg}/\text{cm}^3$ ). Each group consisted of 25 pelts. The object was to examine how morphological/morphometric characteristics correlate with fur properties characterized by physical method. The hair density in three levels (9 mm, 14 mm and 19 mm) relative to the skin surface was quantified.

Hair-morphological parameters were used as objective correlates to the physical measuring values of the hip area of the pelts. Average hair weight/skin area ( $\text{mg}/\text{cm}^2$ ) and average hair length (mm) of under hairs and guard hairs were estimated. Furthermore, the hair fibre composition in the three levels mentioned was analyzed morphometrically. In this way the observed hair fibres were counted, classified as under hair or guard hair, and their cross-sectional area was measured.

Based on the weight of hair fibres it could be documented that the three groups of pelts (high, medium and low density, respectively) differed significantly ( $p \leq 0.001$ ). The hair density measured by physical method particularly correlated positively with 1) the hair weight (level of 9 mm and 14 mm) and 2) the hair length (level of 14 mm and 19 mm).

The hair-morphometric parameters documented that it is the combination of number of hair fibres and their cross-sectional area which determine the hair density. In this connection the effect of hair fibre length was not so important. The cross-sectional area of hair fibres correlated positively with their number ( $r=0.7-0.9$ ), least in the 14 mm level.

It was concluded that physical and morphometric methods can obtain objective, accurate, and detailed knowledge about fur properties in mink including the interaction of different parameters. With physical and morphological measurements as starting points it should be attempted to obtain more information about fur properties in mink.

*NJF report No. 106, 1996, 10 pp. In DANH, 5 tables, 1 fig., 5 refs. Author's summary.*

#### Fur quality of mink skin. Correlation between subjective evaluation and physical-mathematical characteristics

*Outi Lohi*

Fur quality is an important parameter in judging results from fur animal trials. Therefore, objective methods for measuring fur traits would be desirable. Fur quality is a multifactorial trait and thus total description of fur quality requires the use of



several measuring techniques. Two techniques have been developed for measuring the density of fur: Absorption of radiation and pressing technique. Repeatability with the absorption method was high (correlations between repeated measurements,  $r=0.68-0.90$ ). Correlation to subjective evaluation of fur density was significant. The highest correlation ( $r=0.51$ ) was found in the area from 6 to 9 cm from the tail root. Topographic variation could be used to identify pelts with thin haired hip regions. With the pressing technique, the correlation between measurements on different sides of the pelt was fairly high ( $r=0.62-0.72$ ). Correlation to subjective evaluation of fur density was medium high in scanblack ( $r=0.48-0.57$ ) but lower in scanbrown ( $r=0.28-0.30$ ).

*NJF report No. 106, 1996, 8 pp. In DANH, 6 tables, 5 refs. Author's abstract.*

#### **Comparison of pelage development in early and late born blue fox (*Alopex lagopus*)**

*Leena Blomstedt*

Most farmed blue foxes are born in May and in the first week of June. Thus, the age difference between early and late born puppies may exceed one month. In this study, male blue foxes were assigned to an early (May 4-7) and a late born (June 1-4) group (4 animals/group). The pelage development was then studied and compared between the groups. Several skin samples were taken from the hip between August and December. Parameters chosen to delineate the pelage development were the percentage of bundles containing a growing guard hair and bundles containing a mature guard hair, and the number of growing and mature underfur hairs per bundle (mean  $\pm$  SE).

The development of the winter pelage was different in the two groups, both regarding guard hairs and underfur hairs. The percentage of growing guard hairs reached a maximum (98%) in August in the early born group, and in the late born group (99%) a good month later. The number of growing underfur hairs per bundle peaked in mid-September in the early group, but in the late group there was a constant large number of growing underfur hairs during two months from mid-September.

The difference in the developmental pattern of guard hairs evened out by mid-November, when about 97% were mature in both groups. By then 65% of the underfur hairs were mature in the early born group, and 50% in the late born group. At the end of the study period, two weeks later, the corresponding numbers were 81% and 77%. At this stage, the difference in the number of growing underfur hairs per bundle did not reach statistical significance ( $8.5\pm 2.3$  vs  $11.3\pm 2.7$ ,  $p=0.060$ ), but there was a trend towards a larger number of mature underfur hairs in the early born group ( $36.1\pm 1.7$  vs.  $30.5\pm 2.8$ ,  $p=0.051$ ). The pattern of pelage development in the late born puppies resembles that of mink treated with melatonin or with artificial 'short day - long night' light arrangements. Both treatments elevate melatonin concentration in the body, and cause the growth phase of underfur to synchronize.

*NJF Report No. 106, 1996, 6 pp. In SWED, 3 tables, 4 refs. Author's summary.*

#### **Supplement of vitamin E and minerals in feed for blue foxes and mink**

*Øystein Ahlstrøm, Anders Skrede, Knut Nordstoga*

Vitamin E and the selenium containing enzyme glutathione peroxidase have previously been studied in relation to fat quality and unsaturated fat in fur animal diets. Other antioxidative compounds containing minerals such as superoxide dismutase (copper and zinc or manganese) and ceruloplasmin (copper) have not been focused on in the same degree in this context. The exact requirement for antioxidative minerals in fur animals is not established, and in the Nordic countries supplementation of minerals differs. In Finland and Norway, only iron is often supplemented, while in Denmark, copper, zinc and manganese are added too.

Our experiment was carried out to examine the effects of vitamin E, selenium, iron, copper, zinc and manganese on some physiological parameters and production traits in blue foxes and mink in the growing-furring period.

Two feed mixtures were used: one commercial type (A) containing 45% of the fat from marine

sources, and one experimentally made (B) containing 82% of the fat from marine sources. Each of the feed mixtures was added three levels of vitamin E and minerals: one added the recommended level of vitamin E and iron according to Norwegian standard (control), one added extra vitamin E and selenium, and one added extra vitamin E, selenium, iron, copper, zinc, and manganese.

Extra supplementation of vitamin E and selenium or in addition iron, copper, zinc and manganese had minor or no effect on the production traits in blue foxes and mink. However, analyses of blood and liver samples showed in several cases significant effects of the vitamin and mineral supplementation. However, the results did not indicate that extra supplementation was required. Autopsies of animals at pelting showed no macroscopical organ damage in blue foxes. In mink, fatty liver was observed in 13 of 72 animals. Incidences of fatty liver occurred most frequently in mink given feed A which had the poorest hygienic quality. Extra supplementation of vitamin E and minerals did not affect the number of mink with fatty liver in this experiment.

The experimental results do not give basis for extra supplementation of vitamin E and minerals above present Norwegian levels. However, we would like to point out that a longer experimental period, including the reproduction phases, might have given other results.

*NJF Report No. 106, 1996, 10 pp. In NORG, 7 tables, 7 refs. Authors' summary.*

### The intermediate glucose metabolism in the nursing period of the mink

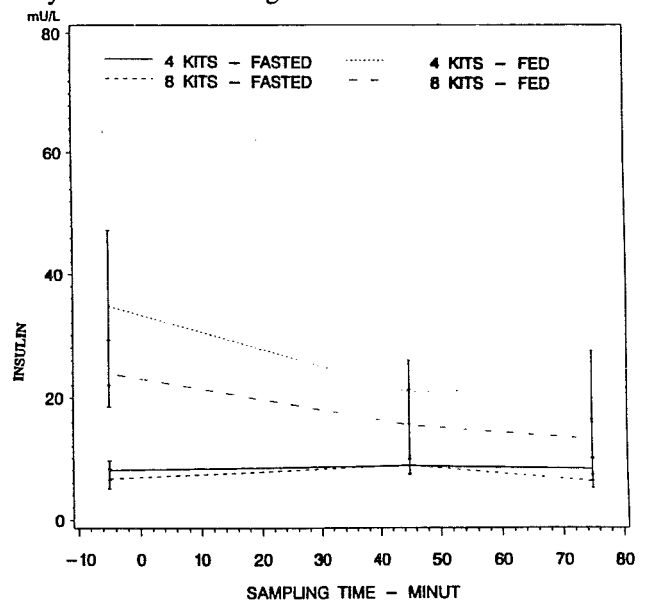
*Christian Børsting, Birthe Damgaard*

The mink is a carnivorous animal adapted to a high protein diet and consequently a large proportion of the absorbed protein is utilized as an energy source. In contrast, the absorption of glucose is low and therefore part of the absorbed amino acids are used as substrates in the gluconeogenesis in the liver. In female mink with large litters the excretion of lactose to the mink is of the same magnitude as the amount of glucose absorbed. This de-

monstrated the need for significant glucose synthesis in the liver to cover the need for glucose in other tissues and organs.

The aim of the present study was to examine the metabolism and regulation of glucose in nursing female mink. For this purpose two glucose turnover studies as well as a glucose tolerance test - reported in a separate paper of this meeting - were performed. In all studies we used the same 2 groups of 5 females fitted with chronic catheters in a jugular vein. The 2 groups of females had 4 and 8 kits, respectively. Total glucose entry rate and the distribution between recycled glucose and net synthesis of glucose was assessed by means of  $^3\text{H}$  and  $^{14}\text{C}$ -labelled glucose.

The tracer technique and blood sampling from the chronic catheters functioned well, also in these females with kits. However, the method seems to affect the females in regard to feed intake, especially females with large litters.



Although the mink is carnivore ingesting only small amounts of carbohydrates, the glucose metabolism was at the same level as in other animal species. Since the mink absorbs only small amounts of glucose compared to other species this result shows the high demand for an optimal glucose synthesis in the liver. Disturbance of this synthesis may be one of the explanations why some females develop nursing disease. Glucose turnover was significantly higher than found in male kits towards the end of the growth period. Glucose turnover was higher in females with large

litters than in females with small litters. Glucose turnover and plasma concentration as well as insulin, total glucagon and pancreatic glucagon levels were increased after feeding. The amount of digestible carbohydrates in the ingested feed accounted for only about 27% of total glucose flux leaving the remaining 73% of the demand for glucose to be synthesized via gluconeogenesis.

*NJF Report No. 106, 1996, 10 pp. 1 table, 2 figs., 10 refs.*

### Effect of different processing of cereals on digestibility in blue foxes and mink

A. Skrede, Ø. Ahlstrøm

In carnivorous animals, it is well known that the digestibility of the cereal starch fraction can be increased by proper processing. Experiments were carried out to study the effects of different processing of wheat, barley, oats, and corn on digestibility in blue foxes and mink. Wheat and oats were fed as raw, autoclaved, expanded and extruded in conventional wet diets. Barley was used as raw, expanded and extruded, while corn was fed raw and extruded. The experimental cereals were fed to adult male blue foxes and standard mink as the sole carbohydrate sources, at a level corresponding to approximately 25 percent of metabolizable energy from carbohydrates.

The overall average digestibilities of crude carbohydrates and starch in blue foxes were 73.7 and 83.2 percent, respectively. The corresponding figures in mink were 68.0 and 80.0 percent. Thus, the average digestibilities were higher in blue foxes than in mink. The largest difference between blue foxes and mink was found for raw corn, where the digestibilities were very low.

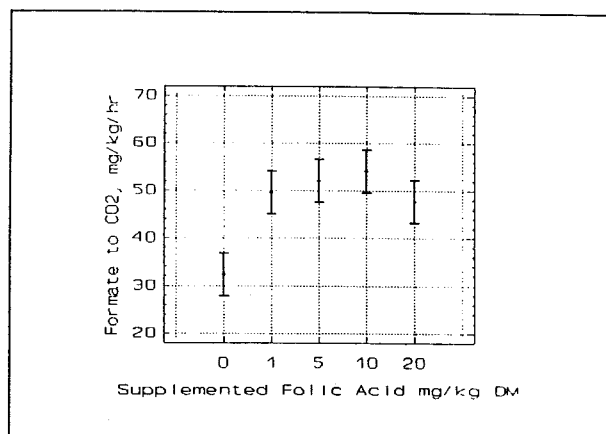
The digestibilities of protein and fat in the feed rations were little influenced by different treatment of the carbohydrate sources. All processing methods improved the digestibility of wheat crude carbohydrates and starch, but there were minor differences between methods. There were only slight effects of processing on digestibility of crude carbohydrates and starch in oats. Compared with

raw barley, expanded, and extruded barley revealed higher digestibility of crude carbohydrates, but there was little effect of processing on starch digestibility. Whereas raw corn was generally poorly digested, the crude carbohydrates and starch in extruded corn were very well digested by both species.

*NJF Report No. 106, 1996, 7 pp. In NORG, 4 tables, 12 refs. Authors' summary.*

### Formate oxidation rate in mink

I. Pölönen, L. Vahteristo, K-R. Hurme, E. Tanhuanpää, A. Uusi-Rauva, J. Mäkelä



**Fig. 1.** Effect of 4-week folic acid supplementation on formate oxidation rate. Each value represents six animals ( $\pm$ SEM) and is calculated as an hourly average excluding the first 30 minutes in a 3-hour test

Young male mink of standard type (N=30) were fed different levels of supplemented folic acid for 4 weeks (0, 1, 5, 10, and 20 mg/kg DM) which resulted in the respective mean hepatic tetrahydrofolate (H<sub>4</sub>folate) concentrations: 3.9, 8.5, 9.2, 10.5, 15.0 nmol/g. Formate oxidation test into CO<sub>2</sub> was carried out in metabolic chambers after mink had been first injected 500 mg/kg LW H<sup>14</sup>COONa (i.p.). The mink that did not receive any supplemented folic acid could convert formate into CO<sub>2</sub> with a rate only 2/3 of the rate of supplemented mink. The experiment showed that formate oxida-

tion rate also in mink correlates with hepatic H4folate concentration. At low levels relationship was linear, but when H4folate level increased to the level which was two times the typical value in the experiment, oxidation rate seemed even to decrease. However, incorporation of formate carbon into liver continued increasing with hepatic H4folate. It can be concluded that in terms of formate oxidation capacity, mink feed can contain 0.35-0.65% formic acid (85% conc.). However, if concentration of natural folic acid in the feed is low and the vitamin is not supplemented, the critical hepatic H4folate level may drop below the level typically analyzed in species that are sensitive to formate, such as humans and monkeys.

*NJF Report No. 106, 1996, 7 pp. 2 tables, 3 figs., 8 refs. Authors' abstract.*

#### **Analysis of Aleutian Mink Disease Parvovirus types in Denmark**

*Elisabeth Gottschalck, Åse Uttenthal, Jørgen Østergård, Mogens Hansen, Per Henriksen*

The autonomous Aleutian Mink Disease Parvovirus (ADV) is found in isolates which vary in pathogenicity. The highly virulent isolates of ADV can cause acute pneumonia with up to 100% mortality in newborn mink kits and progressing immune complex-mediated diseases in adult mink. In contrast, isolates of low virulence cause mortality only in a few mink kits and cause disease only in adult mink of the Aleutian genotype. It has not been possible to distinguish between the isolates serologically, but nucleotide sequence analyses of viral DNA from different isolates have shown, that at least six different types of ADV DNA are present.

In order to analyze the correlation between DNA type and virulence of the isolates, we have developed a method to characterize the ADV DNA from different isolates. ADV DNA from naturally infected mink was amplified by the PCR technique and the different types were recognized using differences in restriction enzyme digestion patterns. The method has been used on ADV DNA from Danish isolates representing 170 farms. The distribution of ADV types and the preliminary results on the

correlation between the types and the severity of the outbreaks of ADV will be presented.

*NJF Report No. 106, 1996, 12 pp. In DANH, 8 figs. Authors' summary.*

#### **Risk factors for wet mink kits**

*Mariann Chriél*

In 1994, a case control study was conducted. A total of 50 farms was included. 23 of the farms reported that wet mink kits were observed, the risk ratio varying from a few litters up till 58% of the litters. 2 farms had problems with the antibiotic treatment of affected litters due to resistance causing high mortality in these farms. In total, 58.049 females/litters were included in the analyses. 3431 litters were diagnosed as wet mink kits.

All farms used computer assisted breeding programmes. The unit of concern was the litter. When the farmer observed a litter with wet mink kits, the diagnosis was registered and transferred to the computer. Furthermore, information from daily deliverance of feedstuff and the declared contents of fat and the percentage of fat fish in the feedstuff was recorded. A total of 12 feeding kitchens were represented in the study.

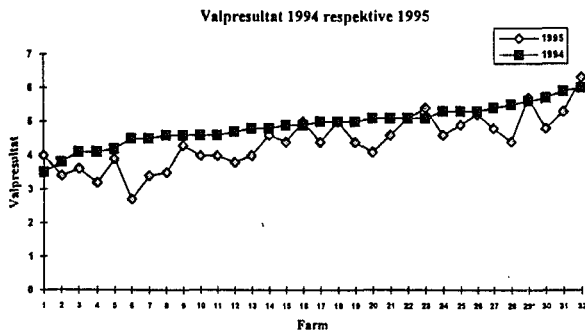
The number of farms included from each feeding kitchen was imbalanced. The data were analyzed by means of bivariate and multivariate analyses. The following risks were found to be associated with high risk of wet mink kits:

- to have late born litters
- to have fed the female very restrictedly in the late pregnancy period
- to have a large litter size
- to have fed the females with a low average of total energy in the last 30 days before birth
- to have first year dams
- to have dams of wildtype

The epidemiological investigation is in accordance with previous investigations performed at the research stations. The mink farmer has to adjust the feed intake so the females are fed according to the

expected date of birth and the litter size in order to prevent restricting the females the sufficient amount of feedstuff for development of mammary gland and intrauterine development of the kits.

Tabell 1.



NJF Report No. 106, 1996, 10 pp. In DANH, 2 tables, 2 figs., 4 refs. Author's summary.

**Mink carcasses composting with manure and straw**

Alfred Baumgarten

Composting of mink carcasses with manure and straw or saw shavings is a real alternative solution of disposing of mink carcasses after pelting. It is suitable both for reasons concerning the environment and the producer's economy.

This study concerns the period between 1991 and 1996 but with the possibilities to go on, depending on the results. The experimental design has a capacity for 400,000 mink carcasses per season. There are two composting bins, each of 180 m<sup>2</sup> (30 m x 6 m), one secondary composting, 200 m<sup>2</sup> (25 m x 12 m), working platform 240 m<sup>2</sup> (30 m x 8 m), a press- and wastewater pool with 100 m<sup>2</sup> and drainage.

The trial's object was about 300,000 mink carcasses which blended with horse manure and chopped straw could assure a compost mix with C:N ratio of almost 15, RH% of 55-60% and with access to aeration.

The compost process concerned two steps:

- main compost, 8 months, between January and August
- secondary compost, 7 months, between September and March.

The operation schedule followed concerned physical, chemical and bacteriological values (volume, odour, temperature, pH, nutrients, pathogens).

Areas as type of construction, substrates, control parameters, environmental impacts are investigated.

The first results showed a satisfactory evolution of the composting process.

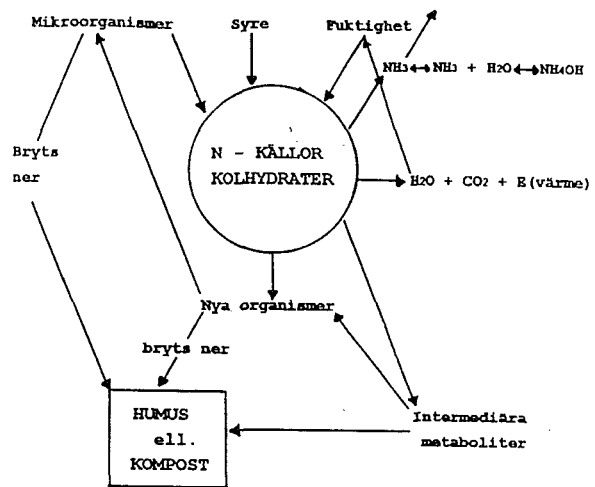


Diagram 1: Komposteringsprocessen

NJF Report No. 106, 1996, 14 pp. In SWED, 3 tables, 6 figs., 33 refs. Author's abstract.

**Glucose tolerance test in mink**

Birthe M. Damgaard, Christian F. Børsting

The glucose tolerance test was performed in mink by intravenous infusion of glucose. The purpose was to measure the response to a standard dose of glucose, and to measure when the plasma concentration of glucose returns to the baseline concentration.

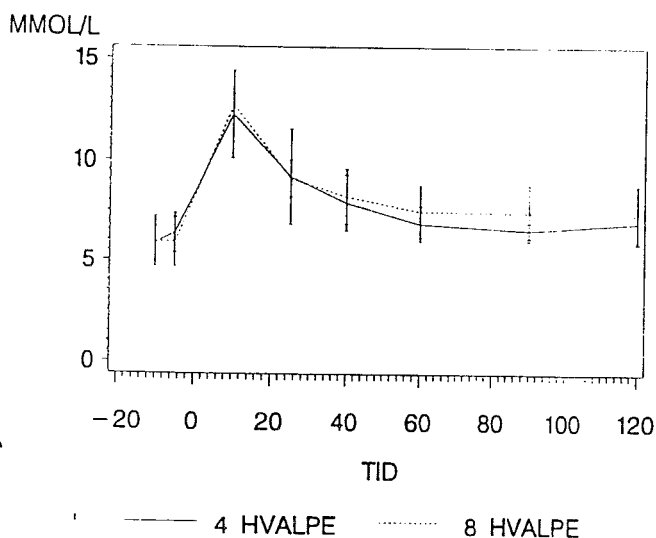
The test was performed with females in the lactation period. The test included 4 females with 4

kits and 5 females with 8 kits. A dose of 0.5 glucose/kg body weight was infused intravenously. Glucose was infused as a solution containing 200 mg anhydrous glucose/ml. The females fasted 2.5 hours before the test.

Blood samples were collected -10, -5, 10, 25, 40, 60, 90, and 120 minutes after infusion of glucose. In whole blood, haematocrit was measured and in plasma the concentrations of glucose, insulin, glucagon, and cortisol were measured. The plasma concentration of glucose peaked 10 min. after infusion of glucose, thereafter the concentration decreased. After 120 min. the concentration of glucose was a little higher than the baseline level.

It is concluded that by intravenous infusion of glucose the plasma concentration of glucose returned to baseline level as in human beings and in other monogastric animals. The glucose tolerance curve was equal for females with 4 and 8 kits.

#### GLUKOSE - TOLERANCE



**Fig. 1.** Glucose tolerance test in mink females with 4 kits and 8 kits after fasting.

*NJF Report No. 106, 1996, 6 pp. In DANH, 1 fig., 3 refs. Authors' abstract.*

#### The heritability of the time of heat and the correlation with other fertility traits in silver fox

*H. Kenttämies, K. Smeds, M. Ojala, V. Vilva*

The heritability of the time of heat and the correlation with other fertility traits in silver fox was studied in a set of data collected from a private farm during 1987-1990. The data consisted of a total of 3657 observations on 2308 females, of which 1711 were yearlings.

The time of heat is taken to be the insemination date, defined as the number of days since the beginning of the year. The time of heat was divided into 7-day intervals when estimating the effect on other traits. The variance components were estimated with an animal model REML. A mixed model was used to eliminate the effect of the year and also the effect of the age of the female when the total material was analyzed. The effect of the time of heat on the other fertility traits was studied with a mixed model where the variance components were estimated with REML.

The onset of heat of the silver foxes occurred within the period from Feb. 3 to Apr. 13, on the average on Mar. 15. Young females came to heat 14-16 days later than the older females. The heritability of the time of heat was 0.34 for the young females and 0.40 for the whole material, the repeatability was 0.84. The effect of the time of heat on the litter size per whelped female was not linear. The conception rate for the young females was at the lowest at the beginning and the end of the season while the conception rate for the whole material was at the lowest at the beginning. The highest conception rates were obtained when the females came to heat at the end of February or the beginning of March. At that time also the litter size per whelped female and the proportion of females nursing their cubs were highest. The effect of the time of heat on the litter size was small, except for young females having the largest litter size at the end of the season.

*NJF Report No. 106, 1996, poster. In SWED.*

### Effect of obstructed view on platform use in juvenile blue foxes (*Alopex lagopus*)

Hannu Korhonen, Paavo Niemelä

The present study aimed to clarify to what extent obstructed view affects platform use in farmed blue foxes from weaning to pelting. Data were collected by daily scanning observations and 24-h video recordings. The results were parallel for both sexes and showed that foxes significantly ( $p < 0.001$ ) preferred open type platforms over wall types. Video recordings revealed that open platforms were used significantly ( $p < 0.01$ ) more for jumping and lying (short duration, 1-10 min on platform) compared to wall platforms. The conclusion was also rather parallel for sleeping use (duration over 10 min). The only exception was in September when females with both platform types slept on them for the same amount of time on average. The disturbance test showed that foxes with open type platforms jumped on them significantly ( $p < 0.05$ ) more often than foxes with the wall type. It can be concluded that foxes avoid platforms with walls because such platforms prevent them from observing their surroundings and thus they cannot adjust their distance to danger.

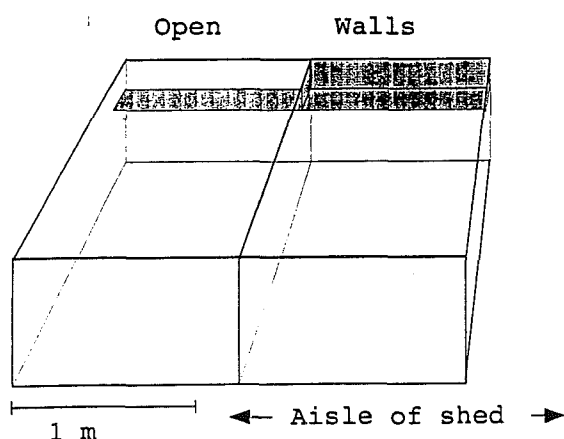


Fig. 1. Schematic picture of the platform types studied.

NJF Report No. 106, 1996, 11 pp. 3 figs., 11 refs. Authors' summary.

### Effect of starvation on the activities of key enzymes of the glycolysis and the gluconeogenesis in liver of mink

I.M. Petersen, O. Sand, P. Grove Sørensen

Along with members of the family of felidea the mink is an obligate carnivore having a demand for a high content of protein in the diet. It seems likely that this demand to the composition of the diet implies that the regulation of the metabolism of the main components of the food in mink differ from that of most other mammals in a quantitative sense. Considering the low content of carbohydrate in the diet, the metabolism of carbohydrate in mink liver could be expected to differ. In mammals one of the main functions of the liver is presumably to maintain blood glucose homeostasis also under the influence of prolonged stress like starvation. In rats, this is achieved, among other means, by induction or repression of some of the key enzymes of the glycolysis and the gluconeogenesis (Pilkis et al., 1988, 1992), enabling the rat liver to change from glycolysis to gluconeogenesis when needed. The present work presents data on the effect of starvation on the activity of the key enzymes of the glycolysis, the gluconeogenesis in male and female mink liver. The effect of starvation on the concentration of glucose and insulin in blood and on liver glycogen is also presented.

During 48 hours of fast, the concentration of blood-glucose declined from 9mM in animals fed ad libitum to 7 mM ( $p < 0.05$ ). The concentration of insulin fell from 40 to 25  $\mu\text{U/ml}$  ( $p < 0.005$ ). Liver glycogen fell from 6 to 0.5 mg/g wet weight ( $p < 0.001$ ). The results were the same for both sexes.

The activities of the following enzymes were examined: pyruvate carboxylase (PC), phosphoenolpyruvate carboxykinase (PEPCK), fructose-1,6-bisphosphatase (FBPase), glucose-6-phosphatase (G6Pase), phosphofructokinase 1 (PFK 1) and pyruvate kinase (PK). Starvation for 48 hours of animals fed ad libitum had no significant effect ( $p > 0.05$ ) on any of the male enzymes and only

# lutreola

Investigations of Mustelids and other Carnivorous Mammals in Russia

Newsletter and Journal "Lutreola" is founded by  
A.N. Severtsov Institute of Evolutionary Morphology & Animal Ecology and  
Mustelid Workshop of the Theriological Society,  
Russian Academy of Sciences

Number 1, 1993

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This Newsletter and Journal, which is to be issued twice a year,  
will feature the following materials:

- original studies of Russian specialists on mustelids and small carnivores (in future it will hopefully cover all the carnivores);
- translations of the most interesting papers appearing in the publications of Russia and other CIS countries;
- comprehensive surveys of all Russian publications on this animal group;
- Russian bibliography, both recent and old, on mustelids and other carnivores;
- catalogues of mustelid collections stored in our museums;
- other information concerned with mustelids and other carnivores.

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A.N. Severtsov Institute of Evolutionary  
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and  
Mustelid Workshop of Theriological Society,  
Russian Academy of Sciences

Number 1

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The Yellow-throated Marten (*Martes flavigula*)

Photo by P. Romanov

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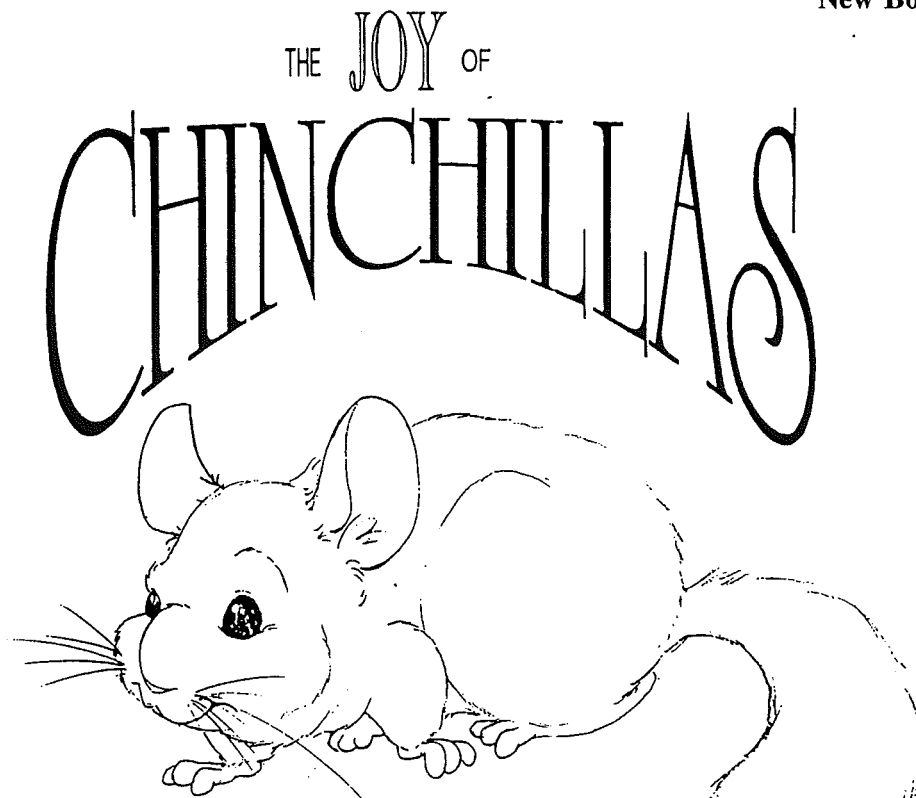
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This edition is a mix between information for the novice owner/breeder and the DVM.

The editor is more for the DVM and some more in depth information for the novice owner/breeder. We did not orient towards the pelt ranchers although the health, nutrition and sanitation applies to all animal practices.

*9 chapters, 52 pp. The book can be obtained from Lani Ritchey, 333 Marmona Drive, Menlo Park, CA 94025, USA*

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# ECOLOGICAL GENETICS IN MAMMALS II

Editors: Günther B. HARTL and Janusz MARKOWSKI

**ACTA THERIOLOGICA** Supplement 3 1995

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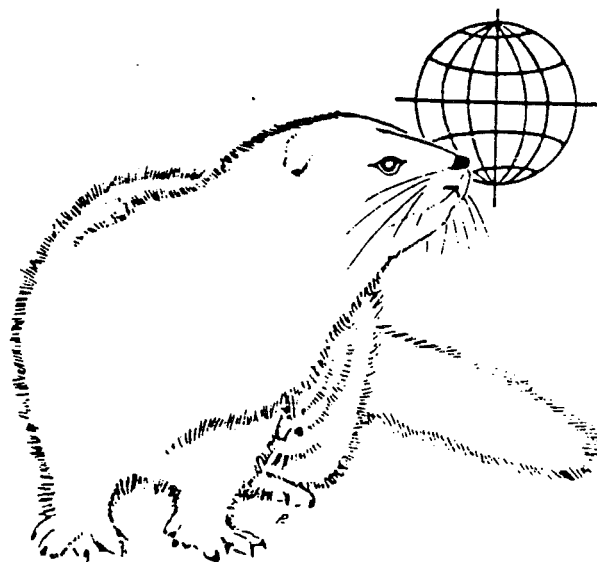
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