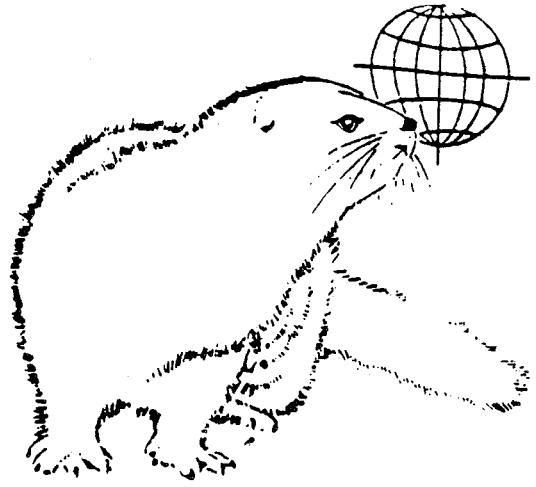

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Titles of other publication – not abstracted

Different time for pelting of mink. *Jostein Reiten. Husdyrforsøksmøtet 1977, Norges Lantbrukshøgskole. In NORG, pp. 337-343. Code 2-12-14-M.*

Adaptation of mink to radio-contaminated environment. *R.V. Trebuhina, G.N. Mihaltsevich, L.K. Lashak, V.G. Petushok, Zh.V. Motilevich, Ye.A. Gritsenko, I.P. Chernikevich. Krolikovodstvo i Zverovodstvo, No. 4, pp. 8-9, 1995. In RUSS. Code 10-9-3-M.*

Chinchillas. Manual of exotic pets. *R.A. Webb, P.H. Beynon, J.E. Cooper (eds.). British Small Animal Veterinary Association, Cheltenham, Gloucestershire GL51 5TQ (UK), pp. 15-22, 15 refs. Code 14-O.*

Lynx. *M.F. Aguilar. Toulouse (France), 150 p., 15 illus., 41 ref., 5 graph. Only title received. Code 1-14-O.*

The European Otter and the European Mink. *J.Y. Gautier, R. Libois, R. Rosoux. Proceedings of the 17th International Mammalogical Conference, Niort, 1993. Universite de Liege (Belgium). Inst. de Zoologie, Lab d'Etologie et de Phychologie animale, Vol. 15 (2-4), 434 p. ISSN 0770-3767. In ENGL, FREN. Only title received. Code 1-14-M-F-O.*

4. Genetics

5. Reproduction

6. Nutrition

7. Veterinary

Titles of other publications – not abstracted

Helicobacter infection in mink. *O.B. Litvinov, A.N. Semikrasova, V.A. Afanaseva, Yu.D. Morozov. Krolikovodstvo i Zverovodstvo, No. 4, pp. 24, 1995. In RUSS. Code 9-M.*

Norstimulin – highly effective therapeutic and prophylactic agent for furbearing animals. *O.A. Pipa, V.A. Afanaseva, A.I. Snitko. Frolikovodstvo i Zverovodsto, No. 3, pp. 24, 1996. In RUSS. Code 9-6-3-M-F-O.*

Cutaneous lymphoma in a ferret (*Mustela putorius furo*). *X. Li, J.G. Fox, S.E. Erdman, D.G. Aspros. Veterinary Pathology (USA),Vol. 32 (1), pp. 55-56, 1995. Code 9-2-O.*

7. Congresses, symposiums etc.

Notes

SCIENTIFUR

Vol. 21 No. 4, 1997

The 50-year anniversary of the Fur Animal Division of NJF (The Scandinavian Association of Agricultural Scientists) and the scientific seminar No. 280, held in Helsinki on 6-8 October 1997 turned out to be one of the very giving occasions in the glorious history of this organisation.

With as many as 24 oral presentations, 14 posters, more than 120 participants and the very good and professional arrangement under the auspices of Hotel Grand Marina and the excellent Marina Congress Centre the occasion was bound to become a huge success.

In connection with the 50-year anniversary, the Board of the Fur Animal Division had asked Niels Glem-Hansen to prepare the history of the first fifty years of the Fur Animal Division of NJF. In a 24 page "Festschrift" the highlights of the years are given.

In the booklet, also some of the "children" of the Fur Animal Division are presented, i.e. the start of the International Scientific Congresses and SCIENTIFUR as well as the "grandchild" IFASA (International Fur Animal Scientific Association) which today stands as the organisation behind SCIENTIFUR.

In connection with the abstracts, Outi Lohi gives short English review of the history written in Danish.

The abstracts from the NJF-seminar published in this issue of SCIENTIFUR show how fast new information can be spread if SCIENTIFUR receives the new material as soon as it is available. The opposite – an unnecessary delay – can be seen with the abstracts in this issue from Anim. Prod. Rev. (Poland) Appl. Science Reports No. 15, 1994, which we only received mid-September this year. We would therefore stress that SCIENTIFUR can only be as up-to-date as you in the scientific fur animal world will allow us to be. Therefore, please send copies of your scientific reports with an English summary as quickly as possible and send us information in English on scientific fur animal events in your area. This of course also goes for proceedings and abstracts – let us have them as soon as possible – in order to help all the users of the information we publish.

Thanks to the economic support from EFBA (European Fur Breeders Association) we can keep our prices at the same level in 1998 as the years before, i.e.

IFASA membership	
Personal members	NOK 170. -
Institutional members	NOK 1,700. -

SCIENTIFUR subscription	
IFASA members	NOK 500. - per vol.
Others	NOK 600. - per vol.

The electronic index covering more than 8,000 titles of scientific reports on fur animal science and production will be updated in January 1998 and the price for this index consisting of 2 diskettes + a manual will also be the same.

The Electronic SCIENTIFUR INDEX

NOK 350. - for IFASA members

NOK 550. - for others

NOK 200. - for updating

Also the year 1997 turned out to be a reasonable year for the fur breeders from a financial point of view even though the market clearly told us that the trees are not about to grow into the sky. Hopefully, it will be possible for the international market to balance production and demand to create a stable situation in the years ahead.

It was very promising to see several old colleagues back in fur animal research as well as many newcomers in the scientific part of the fur animal family during the Scandinavian seminar as well as at the Polish scientific meeting in Kazimierz this summer (so we have been told). Surely this is a sign of optimism in the fur animal industry.

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

Also thanks to the "personal" staff of your editor: Dorthe for typing, Hanne and Marianne for language control and corrections, Jytte for helping the new bookkeeper – i.e. myself – to get on the right track in the electronic jungle. Also Torsteinson and Johansen at the Oslo Fur Centre are acknowledged for their excellent work with the printing and binding of SCIENTIFUR.

With all this we ask you to accept our best wishes for a Merry Christmas and a Happy New Year when we are all looking forward to SCIENTIFUR Vol. 22.

Your Editor

Gunnar Jørgensen

Original Report

Would you like a swim, Madam Mink

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Abstract

The study investigates the potential need of ranch mink to have access to swimming water. For at least a year 32 mink had free access to swim in a basin whereas 32 others did not. In the following two years the average litter size was compared between the two groups. No differences could be detected neither at birth nor at weaning. In one year, the females with access to water lost more youngsters before weaning than did the females without this access. The study concludes that the presence of water for swimming does not induce more or less stress in the mink. At least not at a level where it may affect the reproduction. Accordingly, the possibility of a need in mink to have access to swimming water cannot be proved by this study.

Introduction

Over the last two decades, the general public has become increasingly concerned about animal welfare. This has been followed by public demands of more human methods in animal production facilities. Implementation of this requires facts upon which to base decisions. Thus, science must try to measure and evaluate the level of comfort and wellbeing experienced by animals used in modern husbandry (*Gonyou, 1986*). In addition, it is necessary to increase the knowledge of the need in domestic animals. For several years, the ethology group at the University of Copenhagen has investigated the behaviour of animals in fur production; especially with regard to stress.

Recently, there has been a debate with regard to the need of ranch mink (*Mustela vision*) to have access to water for swimming. This is based on the knowledge of its natural habitat. Being a semi-aquatic mammal it is usually found associated with streams and riverbanks, lake shores, fresh and saltwater marches and marine shore habitats (*Dunstone, 1993*). Broom (1996) defines a need "as a requirement, which is a consequence of the biology of an animal, to obtain a particular resource or respond to a particular resource or bodily stimulus". Ewbank (1985) used more plain language when pointing out that "a need is not an option or luxury but a necessity". Poole (1992) divides behavioural needs into psychological needs and ethological needs. The former are unique to mammals and are needs of the mind. If not fulfilled the animal will experience distress. Unfortunately, this is what Friend (1989) calls a behavioural need. The animal may need to perform a certain behaviour

even if the object of that behaviour, e.g. food, is already present (*Broom, 1996*). Ethological needs are specific requirements for a particular stimulus and deprivation will simply result in the animal not being able to display that behaviour (Poole, 1992). In order to investigate the possibility of swimming being a psychological need in ranch mink, our stress behaviour group set up facilities in 1995 at Farm Nord to accommodate this. The aim is to investigate the differences in behaviour, physiology and reproduction between mink with and without access to swimming water. This paper represents data concerning the reproduction.

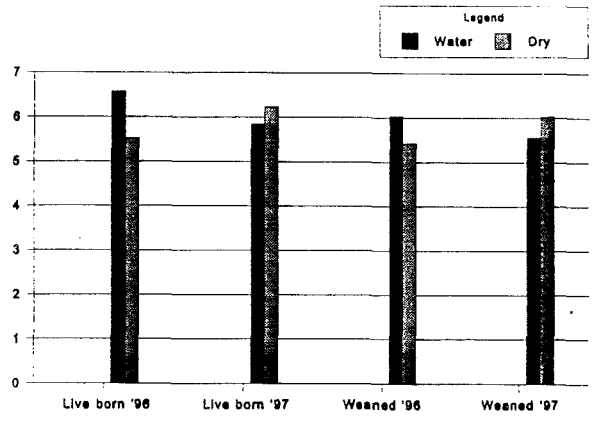
Methods

Sixty-four female ranch mink were placed in two different types of housing. Units consisted of either three standard mink cages (each length 900 mm x width 300 mm x height 450 mm) or three larger standard fox cages (each length 1200 mm x width 650 mm x height 700 mm). The left cage included a nest box, the middle cage a basin covering the entire floor and the right cage was for feeding. Half of the mink were housed in the large units, the other half in the small ones. The connection between the left and the right cage was through either the basin in the middle cage or a tunnel above the basin. In sixteen of the small and sixteen of the large units the box was filled with water and with a few exceptions, cleaned and refilled once a week. In 1996, the thirty-two mink with access to water had had this access for at least a year. They had all either given birth (with water) before or had been born in an environment, which included water.

Both years the females were mated mid March. The litters were born in the periods 26/4 - 7/5 1996 and 24/4 - 10/5 1997. The age of weaning was in 1996 eight weeks and in 1997 six weeks.

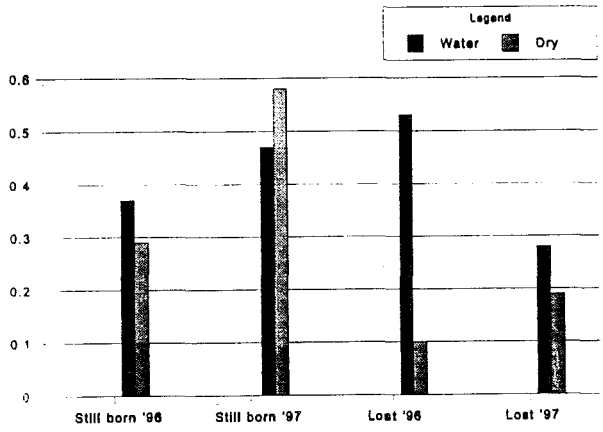
Results

The litter sizes in 1996 and 1997 were counted both at the time of birth and at the time of weaning (Figure A). Pups born as dead were counted as stillborn. As can be seen, there are no differences in litter size at the time of birth or at weaning. The difference between the two counts was calculated to check for any differences in loss of youngsters before weaning. In both years, the loss of youngsters before weaning was greater for mothers with access to water than for those without (Figure B). However, only in 1996 was this difference significant.



P:	0.22	0.62	0.48	0.55

Figure A: Means of litter sizes born and weaned (P: probability (Mann-Whitney U-test)).



P:	0.52	0.33	0.04	0.95

Figure B: Means of stillborns and pre-weaned losses (P: probability (Mann-Whitney U-test)).

Discussion

Both as native in America and as feral in Europe the mink lives adjacent to waterways or the sea. This has given reason to the assumption that mink both in the wild and in production facilities has a natural need to have access to water. If true,

then it is surprising how inadequately the mink is build for swimming and/or diving. According to Williams (1983): "Unlike other semi-aquatic mammals, mink lack specialised appendages for swimming locomotion. Surface area of the feet is relatively small and the toes are only slightly webbed". Normally, semi-aquatic animals have specialised hind limbs to increase surface area for trusting (*Tarasoff et all, 1972*). The small surface area of the mink's feet leads Dunstone (1993) to suggest that it is "adapted for locomotion on land rather than underwater". The use of forepaws and high stroke frequencies, a very energetically costly form of aquatic locomotion, may compensate for this deficiency in mink. (*Williams, 1983*). In addition, its oxygen storage capacity is no greater than that of the non-aquatic ferret *Mustela furo*, although some oxygen conserving responses are invoked during diving (*Stephenson et al, 1988*). Nevertheless, it is a heavy user of water, which is seen in its choice of food.

In the wild, aquatic food can make up a large proportion of its food selection. The proportion may vary according to season and habitat. As Gerell (1967) points out, fish is mainly eaten during the wintertime when they are slower whereas crayfish is preferred during the summer time when they are more vulnerable. This is in contrast to Day and Linn (1972) who claim that the occurrence of both fish and crayfish reach their largest proportion of occurrences in the diet of mink during the summer. This difference may be due to the data collection method (*Day and Linn, 1972*). Nevertheless, the food items in the diet of mink are strongly seasonal. Mink is a very opportunistic feeder and appears to choose between hunting in the aquatic or terrestrial habitats on the basis of food availability and other extraneous factors (*Racey and Euler, 1983*). Positive correlations between mink and wetland bird abundance's has been reported (*Arnold and Fritzell, 1987*). It has been found that sometimes the proportion of aquatic food may be as low as 20 % (*Sealander, 1943; Gerell, 1967*). In male mink it has been seen that they may forage purely in terrestrial habitats (*Birks and Linn 1982*) but not in females.

If this use of water for hunting should have led to a natural need for swimming, one should expect to see some signs of stress in the animals which have no access to perform this possible need. Obviously, this does not mean that signs of stress immediately can be linked to lack of swimming water. Through neuroendocrine and metabolic pathways, stress situations would negatively interfere with reproductive functions, which has been noted in sows (*Smidt, 1994*). These functions may be ovulation, expression of sexual behaviour or implantation of the embryo (*Moberg, 1985*). It has also been observed that reduced stress in female ranch mink can reduce in-utero losses (*Gilber and Bailey, 1969*). Moberg (1987) suggests that "the best indicators of an animal suffering from stress is the development of a pre-pathological state, i.e. a stress-related change in the biological function that threatens the animal's welfare". He then mentions "the loss of reproductive events critical for normal reproduction" as one of these states.

Unlike most other animals, mink are induced ovulators. This means that when the follicles have reached a certain size, the stimulating of mating causes a surge in their growth resulting in the ovulation within 36-42 hours. Consequently, the first copulation may not lead to fertilisation. The ovulation continues after the initial fertilisation and as a result a litter may have different fathers (*Dunstone, 1993*). Since the ovulation is partly dependent on the release of luteinizing hormone (LH), and the control of this is known to be vulnerable to stress, a stressful environment would lead to fewer ovulations i.e. fewer youngsters being born. The reason why it will not completely stop the ovulation is probably that the pre-ovulatory release of LH from the pituitary may be only reduced by a decrease in the pituitary responsiveness to the gonadotropin-releasing hormone (GnRH). This decrease can be caused by increased amounts of adreno-corticotropin (ACTH) (*Moberg, 1987*). It is appropriate to mention that an increase in plasma corticosteroids does not necessarily mean that an animal's wellbeing is threatened. Only when the pre-pathological state has been reached, i.e. a re-

duction in the secretion of LH, can this be said to take place (*Moberg, 1987*). Stress related hormones are also known to inhibit GnRH secretion itself and to alter the stimulatory effect of gonadotropin on sex steroid hormones in the gonads (for a review of stress and the hypothalamic-pituitary-gonadal axis see Rivier and Rivest, 1991).

In this study, no difference in litter size could be detected between any of the groups. This indicates that the absence of water is inducing neither more nor less stress in the females than the presence of water does. At least not at a level where the hormonal control of the reproductive functions are affected. In a series of experiments Cooper and Mason (1997a, 1997b) tried to establish the relative importance for mink of various resources, among these a basin for swimming. They found that the water filled basin ranked equal to hay and novel objects (*Cooper and Mason, 1997a*). Since their animals were not accustomed to this access to water, it is possible that for the animals' bath was nothing but a novel "object". As Gonyou (1986) points out, novelty must be considered when evaluating an environment for physiological or behavioural responses. de Jonge (1996) concluded from his experiment in Holland that the mink only reluctantly entered the water. Unfortunately, he does not state how often they changed the water, which may be of significant importance. In the study presented here, the animals had had access to water for more than a year and the water was regularly changed. Hence, the factors of novelty and disapproval of dirty water can be ruled out.

One area where there was a difference between having access to water or not was in the area of pre-weaning losses. In 1996 the females with access to water lost more than five times as many pups as did the females without access to water. In a previous study conducted by our group (*Jeppesen & Heller, 1986*), it was shown that stressed females suffered a higher infant mortality. The infant mortality in the present study is not necessarily a sign of stress because other factors may be involved. It is known that two of the pups drowned in the basins, which was a real risk the way the experiment was set up.

Regardless of this, other factors caused by the presence of water are probably involved. Since the daily temperatures in 1996 were below those of 1997, a strong heat load combined with a higher relative humidity in nest boxes caused by the mothers bringing water on their fur into the boxes does not seem a plausible explanation. There was one difference in the experimental set up between the two years. In 1996 the pups were weaned at the age of eight weeks whereas in 1997 they were only six weeks old. Unfortunately, no data remains on exactly what age the pups died.

Conclusion

This study did not detect any differences with regard to reproductivity in mink between females with access to water and females without. If reproductivity is taken as one (of many) indicators of stress it can be said that this study does not lead to assume that the lack of access to swimming water induces a state of stress in ranch mink. Accordingly, it could not prove that swimming is a psychological need in mink. While a mammal's behavioural needs must be adapted to life in the wild, many species are sufficiently flexible to accept and enjoy substitutes (*Poole, 1992*). It is true that in captivity mink do use the water (with great individual variation) if it is present but the existence of a need is not proven by its performance when the appropriate stimuli is present (*Friend, 1992*). It must be taken into account that making this conclusion based upon a single parameter cannot be justified. In assessing welfare, Gonyou (1996) stated that "good health and productivity cannot be taken as conclusive evidence of good welfare". This means that in order to fully investigate the possibility of access to water being a need in the mink, we must include other types of parameters. These may be direct hormonal measurements or behavioural responses. The study of these responses is ongoing and will be presented at a later stage.

References

Arnold, T. W., and E. K. Fritzell. 1987. Food habits of prairie mink during the waterfowl breeding season. Can. J. Zool. 65:270-273.

Birks, J. D. S., and I. J. Linn. 1982. Studies of home range of feral mink, Mustela vision. Symp. Zool. Soc. Lond. 49:231-257.

Broom, D. M. 1996. Animal Welfare Defined in Terms of Attempts to Cope with the Environment. Acta Agriculturae Scandinavica Section A Animal Science 0(Suppl. 27):22-28.

Cooper, J. J., and G. J. Mason. 1997a. The behavioural priorities of mink (*Mustela vision*) in a closed economy. Proc. Br. Soc. Anim. Sci.:17.

Cooper, J. J., and G. Mason. 1997b. The effect of costs of access on consumption of environmental resources in mink. BSAS Occasional Publications 20.

Day, M. G., and I. J. Linn. 1972. Notes on the food of feral mink (*Mustela vision*). J. Zool. Lond. 167:463-473.

Dunstone, N. 1993. The Mink. T & A D Poyser Ltd., London.

Ewbank, R. 1985. The Behavioural needs of farm and laboratory animals *in* N. Marsh and S. Heywood, eds. Animal Experimentation: improvements and alternatives. Fund for the Replacement of Animals in Medical Experiments, Nottingham.

Friend, T. 1989. Recognizing Behavioral Needs. Applied Animal Behaviour Science 22:151-158.

Gerell, R. 1967. Food selection in relation to habitat in mink (*Mustela vision*). Oikos 18:233-246.

Gilber, F. F., and Bailey, ED. 1969. Visual isolation and stress in female ranch mink particularly during the reproductive season. Can. J. Zool. 47:209-212.

Gonyou, H. W. 1986. Assessment of Comfort and Well-Being in Farm Animals. J. Anim. Sci. 62:1769-1775.

---. 1996. Design Criteria: Should Freedom of Movement be Retained. Acta Agriculturae Scandinavica Section A Animal Science 0 (Suppl. 27) :36-39.

Jeppesen, L. L., and K. E. Heller. 1986. Stress Effects on circulating eosinophil Leucocytes, breeding Performance and reproductive Success of Ranch Mink. Scientifur 10:15-18.

Jonge, G. de. 1996. Minkens behov av att simma. Våra Pälsdjur 4:74-75.

Moberg, G. P. 1985. Influence of stress on reproduction: measure of well-being. Pages 245-267 *in* G. P. Moberg, ed. Animal Stress. American Physiological Society, Bethesda,MD.

---. 1987. A Model for Assessing the Impact of Behavioral Stress on Domestic Animals. J. Anim. Sci. 65:1228-1235.

Poole, T. B. 1992. The Nature and Evolution of Behavioural Needs in Mammals. Anim. Welfare 1:203-220.

Racey, G. D., and D. L. Euler. 1983. Changes in mink habitat and food selection as influenced by cottage development in central Ontario. J. Appl. Ecol. 20:387-402.

Rivier, C., and S. Rivest. 1991. Effect of Stress of the Activity of the Hypothalamic-Pituitary-Gonadal Axis: Peripheral and Central Mechanisms. Biol. Repro. 45:523-532.

Sealander, J. A. 1943. Winter food habits of mink in southern Michigan. J. Wildl. Manag. 7:411-417.

Smidt, D. 1994. Reproductive management in sows with respect to efficiency and pig welfare. Repro. Dom. Anim. 29:338-339.

Stephenson, R., P. J. Butler, N. Dunstone, and A. J. Woakes. 1988. Heart rate and gas exchange in freely diving American mink *Mustela vision*. J. Exp. Biol. 134:435-442.

Williams, T. M. 1983. Locomotion in the North American Mink (*Mustela vision*), a semi-aquatic mammal: 1. Swimming energetics and body drag. J. Exp. Biol. 103:155-168.

Peace and Happiness Through the Year from the Staff at

IFASA

Original Report

The effect of swimming water and cage size on the behaviour of ranch mink (*Mustela vison*).

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Abstract

The study investigated the behavioural response of ranch mink to the introduction and presence of water for swimming. Forty mink in two different sized environments were given access to water and followed for three months and compared to a control group. Individuals in the small cages expressed more stereotype behaviour and more activity than individuals in larger cages. The difference in activity is explained by a neighbour effect taking place in the small cages. Probably because of the increased risk of a damp nest, animals with access to water spent less time in the nest box than animals in the dry environment. There was also a tendency for them to do more stereotype behaviour, although this was not conclusive. Because the introduction of water was not followed by a reduction in stereotype behaviour, the study does not support any assumptions of swimming water being a behavioural need in mink.

Introduction

In the Western society of today former extensive animal husbandry has changed. Most domesticated species are now kept in intensive units in order to meet the customers' demands of cheap products. This has often meant less stimulating environment for the animals and sometimes inadequate fulfilment of behavioural needs resulting in stress. Indicators of stress include behavioural, physiological and hormonal parameters. In the first category, stereotype movements have for some time been associated with stress (*Fox, 1985*). However, in mink (*Mustela vision*) the link between stereotypies and stress is less obvious (*Bilsøe et al. 1991*). Kennes & De Rycke (1988), working with bank voles (*Clethrionomys glareolus*), call stereotypies a response of the animal to cope with a stressful environment and Broom (1991) generally sees them as indicators of poor welfare. Although it may be difficult to determine whether a stereotypy is helping or has helped the individual to cope with a situation, the stereotypy indicates that the individual has some difficulty in coping with the conditions (*Broom and Johnson, 1991*). Hence, it is often considered an indicator of poor welfare.

Stereotype movements are sometimes linked to behavioural needs. If the environment does not permit gratification of needs an emotive satiation does not occur (*Sambraus, 1985*). This should make the animal develop drive consuming behaviour, for which stereotypy is a candidate. Whether the unfulfilment of a behavioural need leads directly to the performance of stereotypies

(*Hughes and Duncan, 1988*) or installs a state of stress that elicit the stereotypies does not matter with regard to the welfare of the animal. It is still being compromised. In order to recognize behavioural needs Friend (1989) suggests the using of several different techniques. Among these are observations of a species under "natural" conditions and the quantification of responses indicative of stress.

In its natural habitat the ranch mink is associated with various types of water systems and is well known to utilize these environments for hunting (*Dunstone, 1993*). Since the mink is a semi-aquatic animal, it would appear logical to investigate the possibility of access to water for swimming being a behavioural need. Not that the need of a behaviour is proven by its performance when the appropriate stimulus is present. The performance of the behaviour in question could be largely, if not totally, dependent on the presence of external stimuli (*Friend, 1989*). If animals are unable to satisfy needs, they are aware of the deprivation and will experience psychological distress (*Poole, 1992*). Therefore, if swimming is a need in mink, we would expect to see an increase in stress response if mink are deprived of having access to swim. We have previously presented results regarding the impact of such a deprivation on reproduction (*Skovgaard et al., 1997*). The results presented now concerns the behavioural responses, especially stereotyped behaviour.

Methods

In March 1994 sixty-four female and sixteen male ranch mink were placed in two different types of housing. Units consisted of either three standard mink cages (each length 900 mm x width 300 mm x height 450 mm) or three larger standard fox cages (each length 1200 mm x width 650 mm x height 700 mm). The left cage included a nest box, and the right cage included a feeding site. In twenty of the small and twenty of the large units a basin filled with water was installed in the centre cage. The connection between the left and the right cage was through either the basin in the middle cage or a tunnel above the basin. With a few exceptions this was cleaned and refilled once a week. Half the mink of each sex were housed in the large units, the other half in the small ones. Unfortunately, one of the females in a large unit without swimming water died before the start of the observations.

Observations were carried out on twelve days starting one week after mating and continued throughout the pregnancy and lactation (24th March and 22nd June 1994). On each day, ten scannings were made during the activity peak in the morning hours on all animals with ten minutes intervals, giving a total of 790 single observations each day and a total of 120 observations per animal. Both behaviour and position were recorded. The behaviours mentioned in this paper are Stereotypy , Curious and Other Active Behaviours (*Hansen, 1993*). The level of activity was calculated as the sum of the three parameters. Together with Inactive they made up 100 % of an individual's time. Position was recorded as in which cage, in the nest box or in the water.

Results

Generally, the frequency of all the active elements declined in the beginning of the observation period and increased during the last week of the period. This time course was equal to all groups regardless of environment. It was not possible to determine whether this development depended on the mating cycle, the season or the experiment, and for that reason it is not considered further. Mink with access to water showed a remarkable variation in their use of the water. On average the mink spent 1.4 % of scannings (1.67 observations) in the water but 14 mink were not observed being in the water at all. In contrast, one mink was observed being in the water 11 times. The median for the 40 mink was one observation (0.8 %) with no marked difference between mink in different sized cages. On a few occasions, stereotype behaviour was observed being performed in the water. Mainly consisting of fast circle movements while biting on to tip of the tail.

The environmental differences between the cages did result in some behavioural differences between the animals. Mink with access to water

had a significant higher level of activity than the mink without the access (figure A). This meant that they spent less time in the nest box but the time spent in the middle cage was the same for the two groups (figure B). The mink with water expressed more stereotype behaviour although this was not significant (5.6 %). The amount of curiosity was not affected by the environment. Since the level of activity changed, the amount of stereotypy in relation to the activity level was also calculated. This relative level of stereotype behaviour is shown in table 1. As can be seen only the effect of cage sizes was significant (1.9%). The mink with access to water in the small cages expressed more stereotype behaviour both in comparison to the level of activity (P=0.5%) and in real terms (Table 2, P=0.4%) than did the mink in the big cages. In addition, they had a higher level of activity and spent less time in the nest box (figure A). In the small cages there were no differences in amount of stereotype behaviour between those with water and those without (table 2). However, in the big cages this difference was significant (4.9%) with the mink with access to water expressing more stereotype behaviour than those without.

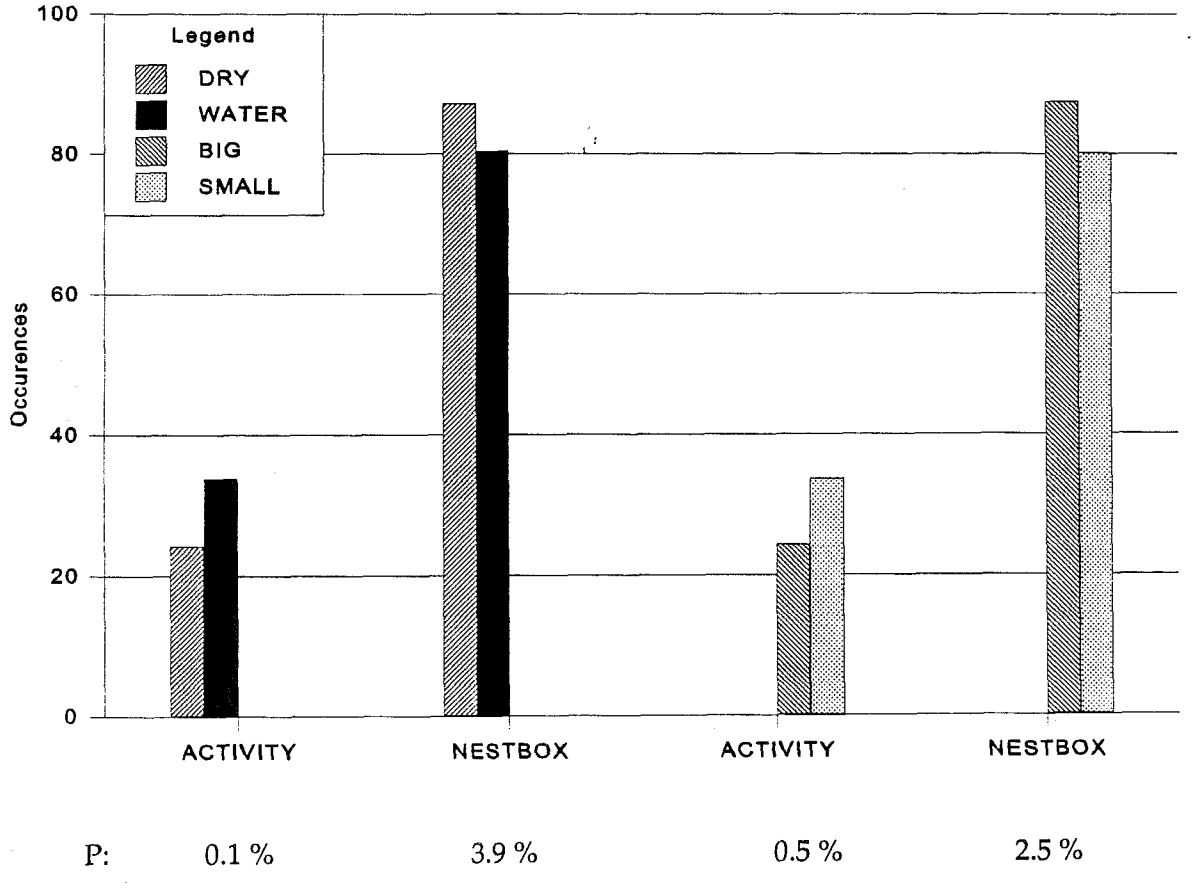

Figure A. The mean occurrences of the behaviour Activity and the placement parameter Nest box for groups of mink in different cage sizes and with or with out water (P: Probability). Wilcoxon 2-sample test, N (dry) = 39, N (water) = 40, N (big cage) = 39, N (small cage) = 40.

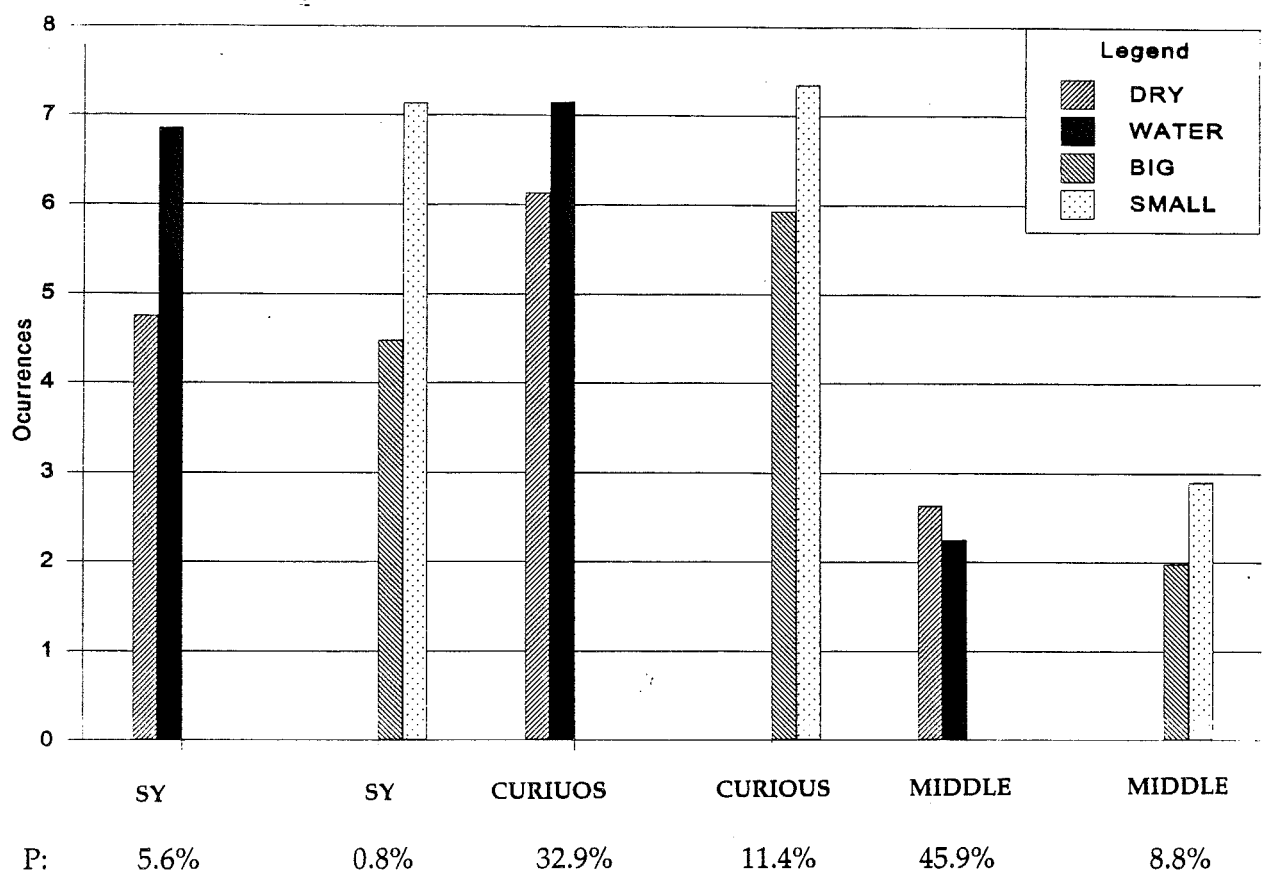

Figure B. The mean occurrences of three behavioural parameters for groups of mink with or without water in the middle cage and in either big or small cages. (P: Probability). Wilcoxon 2-sample test, N (dry) = 39, N (water) = 40, N (big cage) = 39, N (small cage) = 40.

Table 1. The mean relative level of stereotypy between mink with and without water or between mink in large and small cages (P: Probability). Wilcoxon 2-sample test.

	+ WATER (N)	- WATER (N)	P	COMBINED (N)
LARGE CAGE	16.7 % (19)	8.2 % (20)	9.8 %	12.5 % (39)
SMALL CAGE	16.8 % (20)	19.2 % (20)	80.8 %	18.0 % (40)
P	68.3 %	0.5 %		1.9 %
COMBINED	16.7 % (39)	13.7 % (40)	24.8%	

Table 2. The mean occurrence of stereotype behaviour or activity in mink in either big or small cages and with or without access to water (P: Probability). Wilcoxon 2-sample test.

STEREOTYPY	+ WATER (N)	- WATER (N)	P
LARGE CAGE	6.15 (20)	2.80 (19)	4.9 %
SMALL CAGE	7.55 (20)	6.70 (20	46.3 %
P	38.3 %	0.4 %	
ACTIVITY			
LARGE CAGE	29.00 (20)	19.55 (19)	1.4 %
SMALL CAGE	38.45 (20)	28.90 (20)	2.9 %
P	4.4 %	2.5 %	

Discussion

In the wild, the mink is a heavy user of lakes, streams and the sea (*Dunstone, 1993*). When hunting in water, the mink normally detects the prey from the edge before entering. In experimental setups the detection may happen through peering from the water edge or by immersing the head and shoulder to scan under water (*Poole and Dunstone, 1976*). This "head dipping" was observed in our design and has been recorded in the wild too (*Herrick, 1892*). According to Poole and Dunstone (1976) unsuccessful hunts lead the mink to return to the surface to relocate the prey out of the water. This may be due to the fact that the mink has an inferior eye sight in water compared to that in the air. Sinclair et al. (1974) concluded "that mink have not perfected the adaptations of the eye necessary for underwater vison". The reason for this is probably that mink are not only aquatic predators. Although the diet may vary due to season (*Dunstone and Birks, 1987*) or habitat (*Gerell, 1967*) fish and crustacean are normally present. The proportion of the diet coming from the water varies between 20 (*Sealander, 1943; Gerell, 1967*) and 70 percent (*Dunstone and Birks, 1987*). Occasionally, male mink may forage exclusively on terrestrial prey (*Birks and Linn, 1982*). The dual hunting environment means that mink possess very few anatomical adaptations that enhance their ability to hunt underwater (*Stephenson et al., 1988*). Normally, semi-aquatic animals have an increased surface area of the feet to improve thrusting (*Tarasoff et al., 1972*) but this is not very marked in the case of mink (*Williams, 1983*). It is nevertheless an accomplished swimmer both on and below the surface of the water (*Dunstone, 1979*).

Several attempts have been made to improve the welfare of ranch mink and cage size is one factor that previous researches have investigated. In 1988 Hansen (1988) found that mink kept in large cages had a higher level of stereotypy than mink kept in small cages but no difference in the level of activity was detected. The year after, Hansen and Brandt (1989) found that mink kept in large cages had a higher concentration of haemoglobin in the blood, which was taken as an indicator of a higher level of activity. This is in contrast to the study presented here. In this, both the activity and the level of stereotypy (measured in both real and relative terms) were higher in the smaller cages. However, the studies are difficult to compare. The cage sizes in the two previous experiments were 1.056 m^2 (0.802 m^3) for the large cages and 0.270 m^2 (0.121 m^3) or less for the small cages. In our experiment the large units were 2.34

m^2 (1.638 m^3) and the small units 0.810 m^2 (0.365 m^3). In addition, the mink in 1989 were only fifteen weeks when measured whereas our mink were nine to twelve months old. Also, Hansen (1988) suggests that it may not be the frequency but the type of stereotypy, which is affected by the cage size. Pendling was the most dominant stereotype behaviour in the small cages and his result was only achieved by excluding Pendling from the group of stereotype behaviour. This does not seem to be a valid method (*Hansen, 1993*). In our study the increase in the frequency of stereotypy in the small units compared to the big units (18% vs.. 12.5 %) is not present if one looks alone at the units with swimming water. This might be because the water acts as environmental enrichment by that reducing the level of stereotypy in the small cages. However, this is not so. It is the level of stereotypy in the big units that is significantly larger in the group being given access to water than in those without access. The lowest level of stereotypy is observed in large cages without water. It may indicate that cage size is a more important factor in the mink's environment than water for swimming is. A complicating factor is the fact that normal motivated behaviour inevitably looks more stereotyped in the smaller environment.

In its natural habitat the mink spends app. 85% of its time in the nest box (*Dunstone, 1993*). This figure is very similar to those found in our study (80-87%). After swimming, a mink would often spend some time drying itself before entering the nest box. It is possible that the difference in nest box use between those with access to water and those without is caused by an adaptation to avoid to dampen the nest. Another possible explanation is an avoidance of the nests after they got damped. The difference between the big and the small units in the amount of observations in the nest box can easily be explained by the increased activity in the small units. A possible explanation of the increase could be the close proximity to neighbours. The width of the larger units was more than twice that of the small units. Accordingly, activity of a neighbour would stir more in the small units by that creating more activity. It has previously been established that under some circumstances a neighbour effect will occur. However, this was not found to be the case for the level of stereotypy (*Hansen, 1993*). Therefore, further investigation is needed to establish why mink in large cages perform less stereotypy if no water for swimming is present.

In previous publications concerning the importance of access to swimming water our group used the reproduction as a measurement of stress (*Skovgaard et al., 1997*). That study did not indicate any reduced level of stress for animals having had access to water for at least a year. Here we are including the behavioural responses to having access to water in animals not accustomed to this. If the pre-experimental period functioned as a period of deprivation from a fulfilment of a need to swim, the introduction of water for swimming should decrease abnormal behaviour (*Ewbank, 1985*). The frequency of stressed behaviour should decrease and be at the lowest level in the "water" group compared to the "dry" (control) group. This did not happen. On the contrary, the animals that were given access to water had a somewhat higher level of stereotype behaviour than those animals that had never had this access. This does not correspond with previous studies (*Hansen, 1990; Jonge, 1996*) where no differences in abnormal behaviour were found. Again, comparisons are difficult to make. In the one study (*Hansen, 1990*) small trays were used, making it difficult for the mink to actually swim. In the Dutch experiment (*Jonge, 1996*) the mink spend app. 1.8 % of the time in the water, which is more than the 1.4 % in this study. Both studies are well below the 6% and 4% found by Cooper and Mason (1997a, b). They also found a preference for a compartment with water over an empty compartment. This is not confirmed in our study where time spent in the central cage with water equalled time spent in the central cage without water.

The difference in stereotype behaviour between the group with water and the group without was not significant all data combined. In the big cages the group with access to water did perform more stereotypies although this was not the case if the stereotypy was expressed as a fraction of the activity level. This and the fact that on the third and fourth day of observation no stereotypies

were observed in any individual makes it less clear whether the introduction and presence of water for swimming does present a stressful environment to the mink. Obviously, there is no indication of being given access to swimming water reduces the amount of stereotypies. This makes it less likely that there should exist a need in mink for this resource. In addition, it has been observed that swimming does not prevent animals from performing stereotype behaviour at the same time. However, this was done by individuals who were no longer deprived of water. Accordingly, their abnormal behaviour in the water was provoked by something else.

Conclusion

This study did detect some differences in behavioural frequencies between large and small housing units. Probably because of the closeness of their neighbours, the animals in the small units were more active. The presence of water also increased their activity. A difference in cage size seems to effect the level of stereotypy with larger cages having less stereotypy. Water for swimming does not seem to effect the level of stereotype behaviour. If it does, it increases the level. This is not conclusive and was only seen in the large cages. In our previous investigation into another stress indicator, reproduction, we also failed to link the deprivation of swimming water to an increase in the stress response. As mentioned in the introduction, we would expect an increase in stress response to a deprivation of a psychological need. Because of the lack of such an increase, so far, our studies have not been able to prove that access to swimming is a psychological need in ranch mink. Other parameters such as stress hormones are still to be investigated. The results presented here only concern the short term effects of swimming water. The experiment is still ongoing and at present the long term effects on the behaviour are being examined. This will be presented at a later stage.

References

Bilsøe, M., K. E. Heller, and L. L. Jeppesen. 1991. Effects of immobility stress and food restriction on stereotypies in low and high stereotyping female ranch mink. Behav. Process. 25:179-189.

Birks, J. D. S., and I. J. Linn. 1982. Studies of home range of feral mink, Mustela vison. Symp. Zool. Soc. Lond. 49:231-257.

Broom, D. M. 1991. Assessing welfare and suffering. Behav. Process. 25:117-123.

Broom, D. M., and K. G. Johnson. 1991. Stress and animal welfare. Chapman & Hall, London.Cooper, J. J., and G. Mason. 1997a. The effect of costs of access on consumption of environmental resources in mink. BSAS Occasional Publications 20.

Cooper, J. J., and G. J. Mason. 1997b. The behavioural priorities of mink (*Mustela vison*) in a closed economy. Proc. Br. Soc. Anim. Sci.:17.

Dunstone, N. 1979. Swimming and diving behaviour of the mink. Carnivore (Seattle) 1979:56-61.

---. 1993. The Mink. T & A D Poyser Ltd., London.

Dunstone, N., and J. D. S. Birks. 1987. The feeding ecology of mink (*Mustela vison*) in a coastal habitat. J. Zool. Lond. 212:69-83.

Ewbank, R. 1985. Behavioral Responses to Stress in Farm Animals. Pages 71-79 *in* G. P. Moberg, ed. Animal Stress. American Physiological Society, Bethesda.

Fox, M. W. 1985. Philosophies and Ethics in Ethology. Pages 27-46 *in* A. F. Fraser, ed. Ethology of Farm Animals. Elsevier, Amsterdam.

Friend, T. 1989. Recognizing Behavioral Needs. Applied Animal Behaviour Science 22:151-158.

Gerell, R. 1967. Dispersal and acclimatization of the mink (*Mustela vison*) in Sweden. Viltrevy 4:1-38.

Hansen, C. P. B. 1993. Stereotypies in ranch mink: the effect of genes, litter size and neighbours. Behav. Process. 29:165-178.

Hansen, S. W. 1988. Effect of variable cage size and lacks of admission to nest box on the behaviour, physiology and production of mink kits. 4th Int. Sci. Congr. in fur Anim. Prod.:153-163.

---. 1990. Activity pattern of lactating mink and the effect of water trays or wire netting cylinder in mink cages. Scientifur 14:187-193.

Hansen, S. W., and A. Brandt. 1989. Effect of cage size and nest box on the haematological/ enzymological status and physiological stress levels in mink kits. Scientifur 13:185-192.

Herrick, C. L. 1892. The mammals of Minnesota. Bull. Minn. Geol. Sur. 7:1-301.

Hughes, B. O., and I. J. H. Duncan. 1988. The notion of ethological "need", models of motivation and animal welfare. Anim. Behav. 36:1696-1707.

Jonge, G. de. 1996. Minkens behov av att simma. Våra Pälsdjur 4:74-75. (In Swedish)

Kennes, D., and P. H. De Rycke. 1988. Influence of the Performance of Stereotypies on Plasma Corticosterone and Leucocyte Levels in Bank Voles. Pages 238-239 *in* J. Umshelm, G. van Putten, K. Zeeb and I. Ekesbo, eds. Proc. Int. Congr. Appl. Eth. Fur Anim. KTBL, Darmstadt.

Poole, T. B. 1992. The Nature and Evolution of Behavioural Needs in Mammals. Anim. Welfare 1:203-220.

Poole, T. B., and N. Dunstone. 1976. Underwater predatory behaviour of the American mink (*Mustela vison*). J. Zool. Lond. 178:395-412.

Sambraus, H. H. 1985. Stereotypes. Pages 431-441 *in* A. F. Fraser, ed. Ethology of farm Animals. Elsevier, Amsterdam.

Sealander, J. A. 1943. Winter food habits of mink in southern Michigan. J. Wildl. Manag. 7:411-417.

Sinclair, W., N. Dunstone, and T. B. Poole. 1974. Aerial and underwater visual acuity in the mink (*Mustela vison* Schreber). Anim. Behav. 22:965-974.

Skovgaard, K., L. L. Jeppesen, and C. P. B. Hansen. 1997. Would you like a swim, Madam Mink ? Scientifur 21:247-251.

Stephenson, R., P. J. Butler, N. Dunstone, and A. J. Woakes. 1988. Heart rate and gas exchange in freely diving American mink *Mustela vison*. J. Exp. Biol. 134:435-442.

Tarasoff, F. J., A. Bisaillion, J. Pierard, and A. P. Whitt. 1972. Locomotory Patterns and External Morphology or the River Otter, Sea Otter and Harp Seal (Mammalia). Can. J. Zool. 50:915-929.

Williams, T. M. 1983. Locomotion in the North American Mink (Mustela vison), a semi-aquatic mammal: 1. Swimming energetics and body drag. J. Exp. Biol. 103:155-168.

Feliz Navidad
Season's Greetings
Meilleurs Voeux
Glückliche Feiertage
Buon Natale

Original Report

Characterization of keratins from guard hairs of silver foxes displaying the genetic defect "curly hairs" using 2-D gel electrophoresis

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Summary

Keratins were extracted from summer fur guard hairs from normal silver foxes and from animals carrying the genetic defect "curly hair". These keratins were analyzed for amount extracted per weight unit guard hairs and by employing 2-dimensional gel electrophoresis. In both cases no difference was found between the two groups. This indicates that the defect is not caused by uneven keratinization, but the defect may manifest itself with this phenomenon.

Introduction

Guard hairs from silver foxes (*Vulpes vulpes*) and cross bred silver and blue foxes (*Alopex lagopus*) can carry a defect known as "curly hairs". The defect is genetic in origin (*Saarenmaa and Niemelä, 1989*), but the defect gene(s) are not yet identified. Affected animals have fewer guard hairs than normal animals, but not all hairs on the affected animals carry the defect (*Rasmussen, 1988*). Both guard hair and under fur may be affected (*Ingo et al., 1989*). Affected hairs contain parts where the medulla has collapsed and these guard hairs contain more of the amino acid citrulline indicating a defect in the medulla protein Trichohyaline (*Riis, 1996a*). The skin from affected animals has a non-normal *in vitro* kinase activity (*Riis, 1996b*). Uneven keratinization of affected guard hairs and non-normal low levels of Zn have been found (*Ingo et al., 1989*). The animal may carry the defect "curly hair" until it is triggered by a change in environment or management practice or by age, which poses a problem as the defect may have been passed on to the offspring before it is evident.

Hairs are composed almost only of the so-called "hard" keratins. Keratins belong to the intermediate filament protein family and confer the hair its structural strength. α-keratin is the most ubiquitous found keratin, but over 100 different keratin species have been described. The hard keratins contain many disulfide bridges and are insoluble in standard buffers.

In this investigation, keratins from guard hairs taken from the summer pelt from silver foxes carrying the genetic defect "curly hair" and from normal animals were extracted and analyzed using a 2-D gel system.

Materials and Methods

Silver fox guard hairs were cut from the summer pelt of affected and normal animals (*Riis, 1996b*). All foxes were bred at the Experimental fur farm situated at the Danish Institute of Agricultural Sciences, Research Centre Foulum, Tjele, Denmark. The hairs were washed in water and degreased by shaking for at least 30 min. in low boiling petroleum ether (x 2) and finally in acetone (x 2). After degreasing, the hairs were air-dried before keratin extraction. The keratins were extracted in buffer A (8 M urea; pH: 10.0 adjusted with NaOH and 1 mM EDTA) on a rocking table for 24 hr (*Riis, 1997*). Hairs and other debris were removed by centrifugation (10,000 x g for 10 min). S-carboxymethylation of the keratins was done by incubating 5 ml of the samples with 0.4 g Iodoacetic acid and 0.8 g Tris (hydroxymethyl) aminomethane at room temperature for 30 min and stopping the reaction by addition of 0.75 mmole β-mercaptoethanol per sample (*Gillespie and Marshall, 1991*).

Total protein content was estimated with a dye-binding assay (*Bradford, 1996*). Bovine serum albumin was used as the standard, and a commercial kit from BioRad was used. All measurements were performed on a Hewlett Packard 8453 spectrophotometer.

The 2-D gel electrophoresis was performed combining two different protein separation methods. In the first dimension, the keratins were separated according to their netto electrical charge at pH 3.0. This investigation used a development of the method previously published (*Smith, 1994*). Briefly, the separating gel matrix contained 8M urea; 0.9M acetic acid; 0.5% Nonidet P-40; 10% polyacrylamide (30%T, 2.66%C). For polymerization was used TEMED and Ammoniumpersulfate. The stacking gel contained 8 M urea; 0.18 M acetic acid; 0.5% Nonidet P-40; 4.5% polyacrylamide (30%T, 2.66%C). The running buffer was 0.9M acetic acid. The gels were prerun at 145V for 5 hrs. After changing the running buffer to a fresh batch, the samples were loaded and the run was at 145V for 6 hrs. The first dimension was stained using Coo-massie Blue and the protein containing strips cut from the gel and equilibrated for 45 min in buffer O (50 mM Tris pH 6.8; 0.1 M β-mercaptoethanol and 2% sodium dodecyl sulfate) with frequent shift of buffer. The first dimensional gel strip was mounted on top of a second dimension Sodium dodecyl sulfate polyacryl-amide gel, SDS-PAGE. Essentially, this gel was made as described (*Laemmli, 1972*) but with the modification that the gel matrix contained 8 M urea. The SDS-PAGE gels were silver stained as described (*Ansorge, 1985*).

Results and Discussion

The amount of extractable keratin from summer pelt guard hairs from normal and affected animals was measured. The part of the experiment was performed in order to disclose if a difference in extractable keratin could be found between the two groups. This series of experiments did not reveal any difference in the amount of extractable keratin from the two groups indicating than uneven keratinization is not caused by difference in the amounts of keratins within the two groups (table 1).

Table 1. Keratin extraction from guard hairs of summer pelts. The extraction was performed for 96 hr. The difference is not statistically significant.

Guard hairs from	n	Keratin extracted (mg/ml)	S.D.	C.V.
Silver fox (*normal*)	3	20.767	1.33	6.40
Silver fox (*curly hair defect*)	3	21.047	1.09	5.18

After this analysis, 2-D gel electrophoresis of the keratins was performed in order to test if the extracted keratins were of different composition. Several different procedures for performing the first dimension were tested, but the method described under Materials and Methods was found to be the most efficient. Analysis of the 2-D data could not disclose any differences in the patterns found on the gels when the first dimension separated the keratins according to the protein netto charge at pH 3.0, and the second dimension separated the keratins according to size (fig. 1).

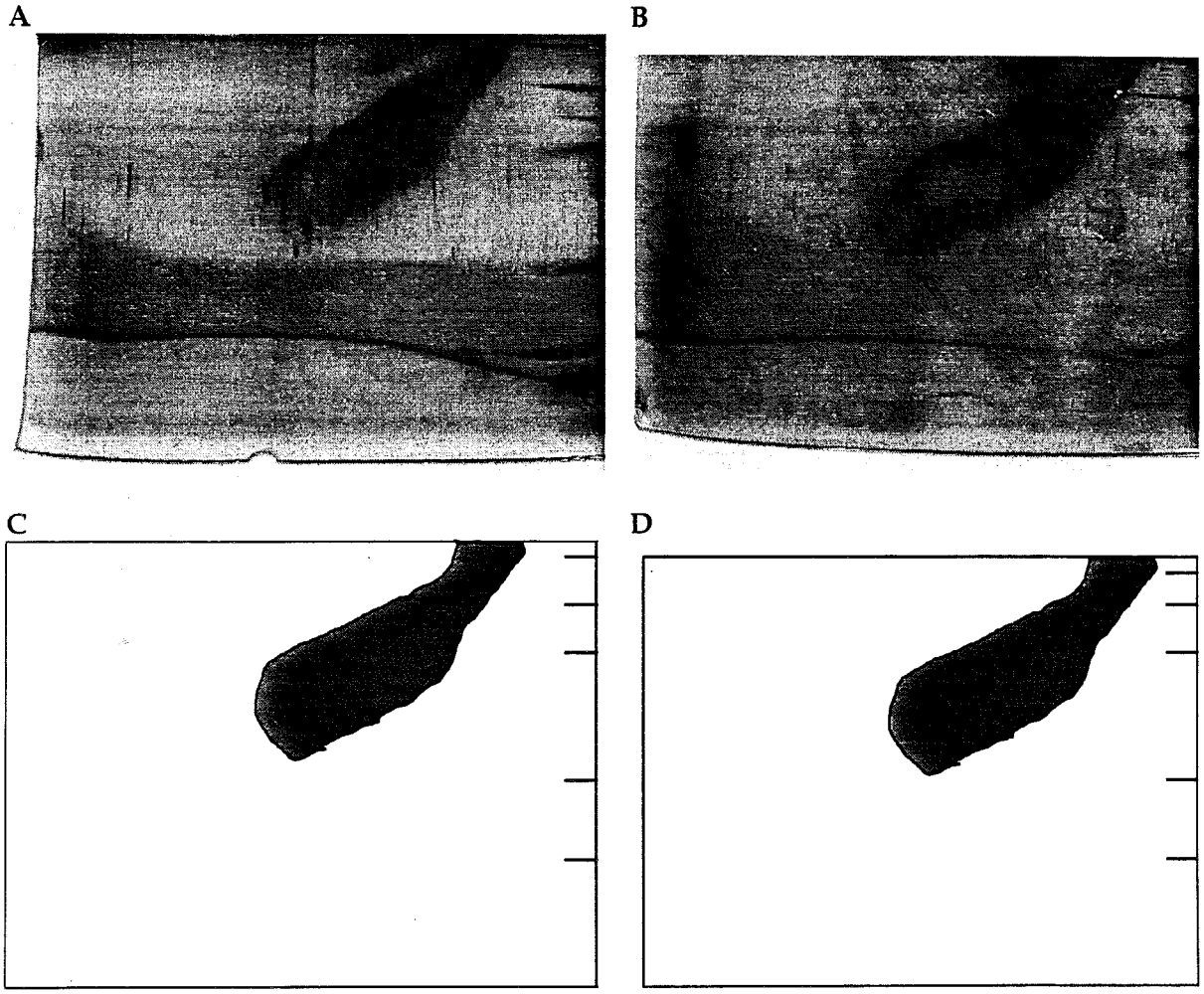

Figure 1. Two-dimensional separation of keratins from guard hairs of summer pelts from silver foxes displaying the genetic defect "curly hairs" **A** and from normal animals **B**. Because the gels have a very high background it can be difficult to see the separated proteins. The reason is the staining technique. The explanatory shaded areas in the drawing show the result from affected animals, **C**, and from a normal animal, **D**. The horizontal bars shows the molecular weight markers used in both **A** and **B**.

A similar result was observed when the keratins were S-carboxymethylated before the analysis, although this treatment is known to affect the protein chemical characteristics (data not shown). As it can be seen clearly from the explanatory drawings in figure 1, **C** and **D**, very little difference is found between affected and normal foxes when the extracted keratins

are separated using the 2-D gel system. When looking at the original gels (fig. 1**A** and **B**), it may be difficult to distinguish the separated keratins clearly. This is partly due to the fact that the silver staining method stains everything very efficiently and partly that it is known that separation of keratins using 2-D gels is very difficult (*Marshall and Gillespie, 1991*).

Conclusions and Perspectives

To the best of my knowledge, this is the first time where the keratins extracted from silver foxes carrying the "curly hair" defect have been analysed using the 2-D gel methods. However, no difference was found in the 2-D pattern when compared with normal foxes and no difference in amount was found between the two groups when studying the extraction efficiency. This study finds that the guard hairs from affected animals are constituted by the same "hard" keratins as guard hairs from non-affected animals. Previously, it has been reported that some of the guard hairs from affected animals display an uneven keratinization (*Ingo et al, 1989*), but this study was unable to support this view. However, the explanation can be that only part of the hair is affected and another result might be found if only the affected part of the hairs were compared with non-affected hairs. Another result might also occur if guard hairs from winter fur were analyzed. The reason behind the defect is still unknown, but previous reports have indicated a malfunction in the hair medulla which has been shown to be constituted by Trichohyaline. A collapse in the medulla may explain the uneven keratinization of the surface of part of the hairs, which was seen in a transmission electron microscope (*Riis, 1996a*).

References

Ansorge, W. (1985) Fast and sensitive detection of protein and DNA bands by treatment with potassium permanganate, J. Biochem. Biophys. Methods, **11**, 13-20.

Bradford, M.M. (1976) A rapid and sensitive method for quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. Anal. Biochem., **72**, 248-252.

Gillespie, J.M. and Marshall, R.C. (1991) The proteins of normal and aberrant hair keratins. *In:* Hair Research (Orfanos, Montagna and Stüttgen eds.) pp 76-83. Springer Verlag, Berlin, Germany.

Ingo, R., Blomstedt, L., Työppönen, J., Kangas, J. and Valtonen, M. (1989) Krullhårighet hos silverräv. NJF Seminar Proceeding **170**, 26-35.

Laemmli, U.K. (1970) Cleavage of structural proteins during the assembly of the head of Bacteriophage T4, Nature, **227**, 680-685.

Rasmussen, P.V. (1988) Morphological description of abnormal guard hairs of mink and silver foxes. 4th Inter. Cong. on Fur Animal Production, Rexdale, Ontario, Canada.

Riis, B. (1997) Keratins extracted from mink and fox hairs characterized by capillary and gel electrophoresis. Proceeding of the 50th years anniversary NJF meeting. Submitted.

Riis, B. (1996a) Undersøgelser af hår fra sølvræve med defekten "krøllede hår". Faglig Årsberetning 1996. pp175-180. Pelsdyrerhvervets Forsøgs- & Rådgivningsvirksomhed A/S.

Riis, B. (1996b) *In vitro* protein kinase activity of skin biopsies from silver foxes displaying the "curly hair" defect. Scientifur, **20**, 345-349.

Smith, B.J. (1994) Acetic-acid polyacrylamide gel electrophoresis of proteins. In Basic protein and peptide protocols. (Walker, J.M. ed.) Series: Methods in molecular biology 32. pp 39-47. Humana Press, Totowa, New Jersey, USA.

Saarenmaa, K. and Niemelä, P. (1989) Ärftlig krullhårighet hos silverräv (*Vulpes vulpes*). NJF Seminar, Stockholm, Sweden.

Original Report

Specificity of metabolic characteristics of farm-bred white mink

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Summary

The isoenzyme spectra of lactate dehydrogenase (LDH, EC 1.1.1.27) in the blood serum, liver, skeletal muscles and heart of Hedlund (hh) type white mink and some biochemical blood indices were investigated. White mink are shown to perform some functions in a conservative manner and display a glycolytic type of metabolism. They retain the species and tissue specificity of isoenzymatic LDH spectra, and their morphological blood indices have a broader "health standard" range.

Introduction

The study of metabolism intensity in fur-bearing animals is of primary importance for the breeding of new colour types of mink because it helps to determine whether some interior indications depend on genesis (*Berestov, 1971; Petrova, 1971*). In mink the hematological indices of protein, fat and carbohydrate metabolism are shown to depend on the colour type of an animal (*Berestov & Tyutyunnik, 1969*). K.V. Makridina (1967) has revealed that the oxidative metabolism of Hedlund-type mink is commonly higher than that of standard American mink. There are other differences between the white mink and the standard American mink. White mink are less fertile, their body size and live mass are smaller, and their retardation processes are more vigorous. In addition, they are commonly deaf. However, the Hedlund-type (hh) mink, a white monorecessive mutant, produced by gene mutation and breeding in cages, has a commercial value. There are no references to wild coloured mink in the literature.

The adaptation of the organism to environmental conditions depends basically on its major constituent, known as energy metabolism (*Kalabuhov, 1946*). The fur colour of animals is assumed (*Schwarts,1959*) to depend on their heat balance pattern and heat production mechanisms in which alternative ways of production of energy-rich compounds play an important role. It is interesting, therefore, to study the glycolytic metabolism and total metabolic level of white mink by estimating their serum enzyme activity and to compare them with those of standard mink and polar foxes.

Materials and methods

Adult Hedlund (hh)-type mink, reared on Karelia farms were studied. Material used for the study of LDH isoenzymes, such as blood serum and tissue samples was obtained in the pelting period. Morpho-biochemical blood indices were studied in females during anestrus and lactation.

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.), and alkaline phosphatase (AP, EC 3.1.3.1.) were determined by the microexpress method (*Berestov, 1981*). Superoxidedismutase (SOD, EC 1.15.1.1.) was measured in erythrocytes using the adrenochrome method (*Ilukha, 1991*). Multiple molecular forms of lactate dehydrogenase in blood serum and organ extracts were analysed by agar gel electrophoresis (*Berestov & Kozhevnikova, 1981; Meldo et al., 1987*).

Result and discussion

It has been shown by analyzing the isoenzymatic spectra of LDH, obtained for the blood serum and organs of white mink (Table 1), that they are all represented by five molecular forms. The LDH spectra of mink organs were tissue-specific and corresponded to the metabolic type of tissue. For example, the liver and the skeletal muscle, which characteristically displays an anaerobic type of metabolism, showed the highest activity of cathodic forms (a total of LDH-4 and LDH-5 accounted for 74.6% of total lactate dehydrogenase activity) and low anodic activity. In the heart, which has an aerobic type of metabolism, the highest activity was shown by rapid fractions (a total of LDH-1 and LDH-2 made up 60.38%, and that of LDH-4 + LDH-5 was only 11% of total activity).

Blood serum reflected the type of metabolism common to the semi-aquatic predators of the marten family, in which, unlike land species (e.g. polar fox), subunits responsible for the anaerobic pathways of glycolysis were predominant. Thus, a total of cathodic fractions was 36.59% and that of anodic fractions was 29.50% of total LDH activity.

Comparative analysis (Table 1) of the total percentage of A and B subunits in the organ spectra of white and standard mink and polar fox has shown that the percentage of A subunits in white mink is similar to that in standard mink and much higher than that in polar foxes. Thus, in spite of the fact that the American mink mutant was kept in captivity for a long time and had no water to swim in, it retained its biochemically evolved ability to function under forced hypoxia conditions. At the same time, their total LDH activity level is slightly shifted (Fig. 1), although their species specificity, apparent as a relationship between the molecular forms of enzyme, i.e. the predominance of A subunits in comparison with land predators, is retained.

We have shown earlier (*Berestov & Kozhevnikova, 1981*) that unlike standard mink, coloured mink (silverblue, pearl and pastel) show differences in total LDH activity only during the most critical periods, i.e. after weaning of kits and when mink are preparing for winter time. No obvious differences in average annual LDH values were observed in adult mink, and the activity of this enzyme in mutant forms was equal to that observed in their wild relatives, notably the original form of American mink. The lower LDH activity of white mink, as compared to that of standard mink, could indicate a decline in the proportion of glycolysis in the energy production chain. This, in turn, suggests that oxidative metabolism is more intense in white mink than in standard mink. This was shown earlier by K.V. Makridina (1967) who reported that heat production, estimated for white mink, was 32% higher in males and 22% higher in females than for standard mink. Considering some aspects of her experiments (e.g. white mink were always smaller than standard ones), her data can be interpreted with regard to the well-known relation of total metabolic intensity to body size, rather than the pleiotropic effect of colour genes.

Table 1. Distribution of LDH isoenzymes in different organs and tissues of mink (standard and hedlund) and polar fox

Species, Colour	LDH fraction, % of total activity					Content of subunit, %	
	1	2	3	4	5	A	B
Liver							
Hedlund mink	1.15	3.14	11.05	14.09	70.56	87.44	12.56
Standard mink	2.11	4.15	11.21	12.84	70.39	86.66	13.34
Polar fox	8.57	5.99	7.59	7.93	68.00	79.24	20.76
Skeletal muscle							
Hedlund mink	1.26	2.60	15.18	25.58	56.73	84.16	15.85
Standard mink	1.25	6.53	16.82	17.38	57.67	80.75	19.25
Polar fox	23.97	17.36	6.18	8.98	45.05	59.22	40.78
Heart							
Hedlund mink	26.11	34.27	28.43	8.19	3.00	31.93	68.07
Standard mink	32.87	36.95	24.07	4.47	1.62	26.25	73.76
Polar fox	54.25	36.05	4.20	2.70	2.57	15.71	84.29
Blood serum							
Hedlund mink	13.90	15.60	37.6	12.71	23.88	56.11	43.89
Standard mink	17.13	12.09	28.66	8.54	33.58	57.34	42.66
Polar fox	38.80	8.50	9.10	7.90	35.50	48.10	51.90

If, however, the average annual values of some biochemical indices, obtained for mink that differ in colour, are compared with those for polar foxes (Fig. 1), then one can see that white mink differ in metabolism and that metabolic differences are apparent in blood serum. In white mink, the above indices vary over a broader range which agrees with their physiological standard. One can see that, on one hand, in white mink the upper boundary of the above standard is more extensive in terms of the number of erythrocytes, hemoglobin concentration as well as ASAT and ALAT activity. On the other hand, their LDH

activity varies over a more narrow range (5.69 - 13.61 μM/ml) than in standard mink (5.13 - 15.41) and over a much wider range than in polar foxes (2.80 - 7.34 μM/ml), thereby indicating that the proportion of glycolysis in the metabolic chain is higher in mink (regardless of colour) than in polar fox.

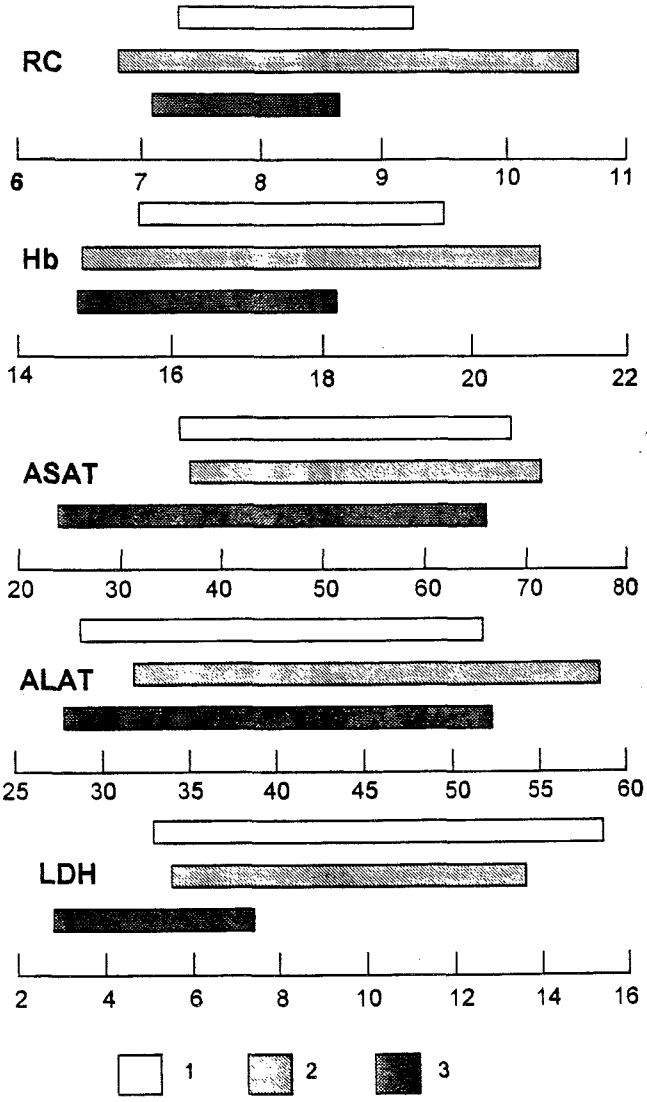


Fig. 1. The annual level of blood morpho-biochemical indices in mink and polar fox (mean±SD). 1 – standard mink, 2 – Hedlund mink, 3 – polar fox.

Considering that in white mink the variation range of the above indices becomes wider, it was interesting to study their "standard response" by assessing their adaptability

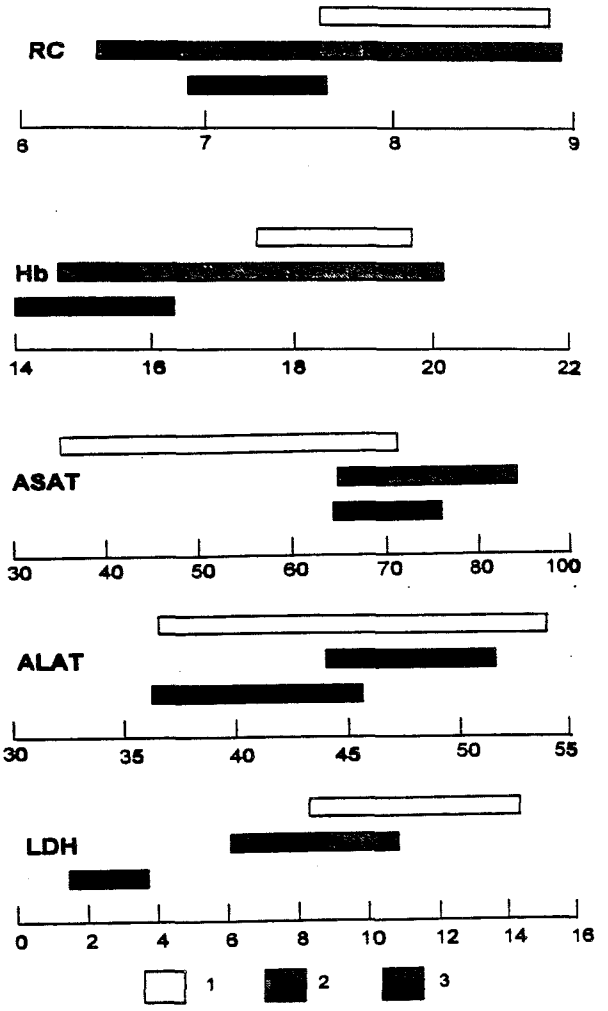


Fig. 2. The level of blood morpho-biochemical indices in mink and polar fox in the lactation period (mean±SD). 1 – standard mink, 2 – Hedlund mink, 3 – polar fox.

during some critical (e.g. lactation) periods in comparison with the anestrus period (Fig. 2). One can see that during lactation, when all the functions of the organism are stressed, the ASAT activity increased sharply to 76.5 unit, thereby exceeding the level observed in standard mink (58.7 units), and LDH activity decreased to 8.43 μM/ml (11.38 in standard mink), but remained normal. SOD activity in blood erythrocytes was lower in white mink than in standard mink and correlated with hemoglobin level. The above data show that with a rise in pressure on the organism of white

mink, their biochemical indices respond more strongly within the confidence limits of the standard. At the same time, the variation range of their indices became more narrow relative to the standard, and differences between white and standard mink increased, suggesting that they differ in adaptability. The indices studied have not been shown to be highly variable, indicating that "standard response" is the same for the white mink population.

Thus, the biochemical functions of white mink, intrinsic to the marten family and apparent as the predominace of the glycolytic type of metabolism, are more conservative than those of the *Canidae* family. The isoenzymes LDH spectra of their organs and blood serum are tissue-specific. Some morpho-biochemical blood indices vary over a wider range which correspond to "standard health", but are slightly shifted relative to the standard towards the values characteristic of polar foxes.

Acknowledgements

This work is supported by grant 96-04-48649 from the Russian Foundation of Fundamental Research and grant "Fur animals" from Russian Ministry of Science.

References

Berestov, V.A., Tyutyunik, N.N. 1969. Level of lipids, cholesterol and lipoproteins in blood serum of furbearing animals. In: Scientific proceeding of Petrozavodsk University, Vol. 17, No. 4, pp. 21-29.

Berestov, V.A. 1971. Blood biochemistry and morphology of fur bearing animals. Petrozavodsk, 291 pp (in Russian).

Berestov, V.A. 1981. Laboratory methods for estimating the state of furbearing animals. Petrozavodsk, 152 pp (in Russian).

Berestov, V.A., Kozhevnikova, L.K. 1981. Blood enzymes of furbearing animals. L. "Nauka", 186 pp (in Russian).

Ilukha, V.A. 1991. The modification of method of the SOD activity determination in reaction of inhibition autooxidation of epinephrin. In: The metabolic regulation of the fur bearing animals physiological status. Petrozavodsk, pp. 135-139 (in Russian).

Kalabuhov, N.I. 1946. Preservation of energetic balance of organism as basis of adaptation processes. J. General Biology, Vol. 7, No. 6 (In Russian).

Makridina, K.V. 1967. Heat production in standard and colour mink. In: Scientific proceeding of Petrozavodsk University, Vol. 15, No. 4, pp. 39-46 (in Russian).

Meldo, H.I., Unzhakov, A.R., Ostashkova, V.V. 1987. Peculiarity of fur bearing LDH isoenzymes electrophoretic separation. Methodical approach to studying physiology of fur animals. Petrozavodsk, pp. 28-36 (in Russian).

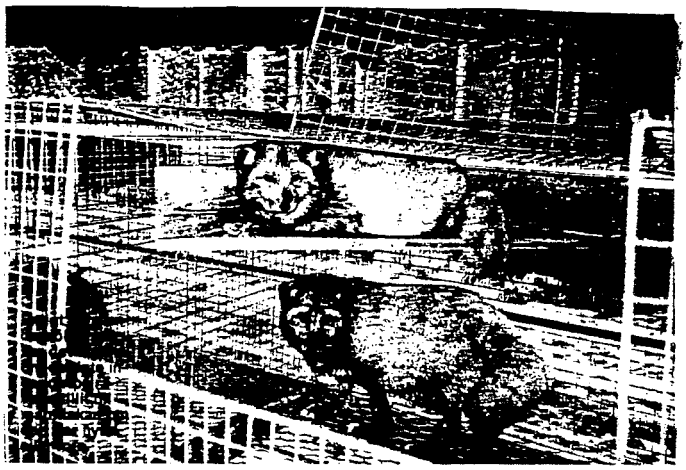
Petrova, G.G. 1971. Age and seasonal dynamics of hematological indices in different colour mink (*Mustela vison Br.*). Ph.D. thesis. Petrozavodsk, 18 pp (in Russian).

Schwarts, S.S. 1980. Ecological regularity of evolution. Moscow, 280 pp. (in Russian).

Effects of shelves and human contact on temperament in foxes

H. Korhonen, P. Niemelä

After weaning, young blue foxes were housed singly (1) in a cage with no shelf and with exposure to humans, (2) in a cage with a shelf, but no internal wall, or (3) in a cage with no shelf or internal walls, and foxes in 2 control groups were housed in traditional cages with or without a shelf (groups 4 and 5). Foxes in group 1 were less distrustful than those in the other groups, but there were no significant differences in temperament between the other 4 housing groups, and there were no differences between the sexes.



Finsk Pälstidskrift 30, 1/2, pp 21-23, 1996. In SWED. 1 table, 1 fig., 2 photos, 10 refs. CAB-abstract.

The catalogue of Nordic research projects on fur animals

Outi Lohi, editor

The third edition of the catalogue was in the beginning of 1997 launched by the Fur Animal Division of the Nordic Association of Agricultural Scientists. All projects presently running or completed within the last two years are included. Altogether 121 projects are presented with title, participating institutes and researchers, time schedule and a short description of the present status or achieved results. The catalogue is mainly in the Scandinavian languages but the titles are also given in English. The Nordic catalogue will be updated yearly and the next edition is due by May 1998. We are also working on making it one of IFASA's future activities to have a corresponding international list available in English at the WWW on Internet.

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

Breeding and genetics	22 projects
Biotechnology	4 projects
Nutrition, feeding and feed ingredients	20 projects
Physiology	11 projects
Hair and skin	12 projects
Reproduction	3 projects
Animal health, diseases, vaccination	13 projects
Animal welfare, behaviour, ethology	28 projects
Production systems	4 projects
Economics	2 projects
Environment etc.	2 projects

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Book, 70 pp, 1997. In Nordic Languages with English subtitles.

The influence of fur animal farms on ground water quality

M. Fic, K. Skapski, J. Slawon, H. Bis-Wenzel, L. Saba

The influence of fur animal farms on ground water quality in Konstancin-Jeziorna was studied. Some physical and chemical properties of infiltrating water and ground water were tested. Samples of soil-water were collected from the unsaturated zone with the use of ceramic porous cups, from three different soil profiles. The first soil was a naturally sandy soil, in the second and third soil, the upper lay-

er of a thickness of 10-15 cm was replaced with peat and gravel, respectively. Results of a chemical analysis did not show any significant influence of upper soil layer on soil water quality.

Additionally, ground water samples, which were collected from piezometers, were tested. The piezometers were located on the farm and in surrounding areas under different soil-water conditions. The results of chemical analysis showed big differences in the concentrations of pollutants in ground water, especially differences of nitrate-nitrogen concentrations were very high. Such results show importance of a proper location of wells for a drinking water supply for the farm.

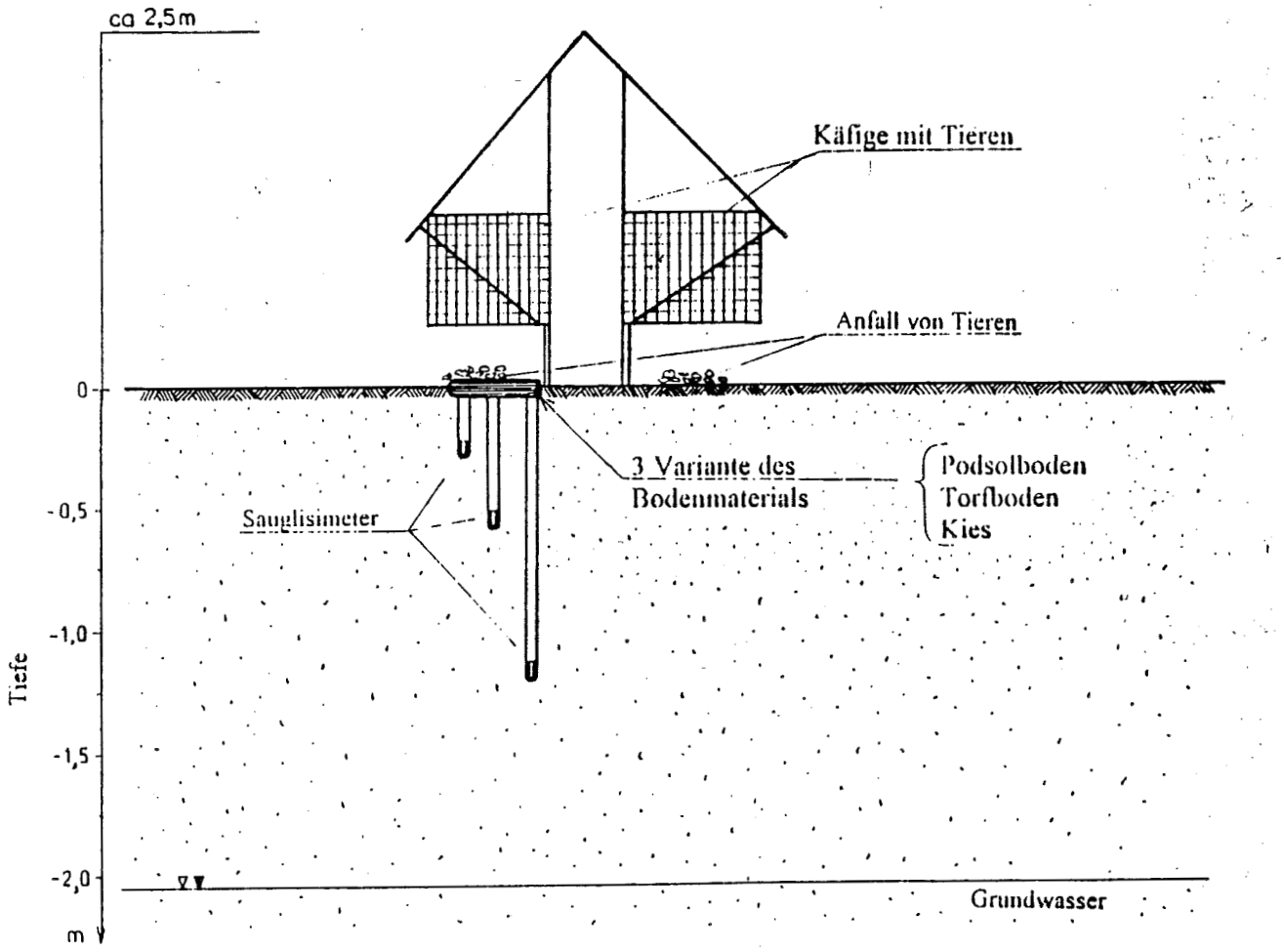

Fig. 2. Schnitt durch das Versuchsfeld – Aufbau des Sauglysimeterversuches

7. Gumpensteiner Lysimetertagung "Lysimeter und nachhaltige Landnutzung", BAL Gumpenstein, 7.-9. April 1997, pp. 55-60. 3 tables, 3 figs., 8 refs.

Effects of provision of permanent shelves on pelt quality in silver foxes

H. Korhonen, P. Niemelä

From weaning to pelting, 28 male and 28 female silver foxes were housed in single cages, with or without U-shaped wooden shelves measuring 103 x 30 cm, and positioned 23 cm below the roof. There were no significant differences between the 2 groups in pelt quality.

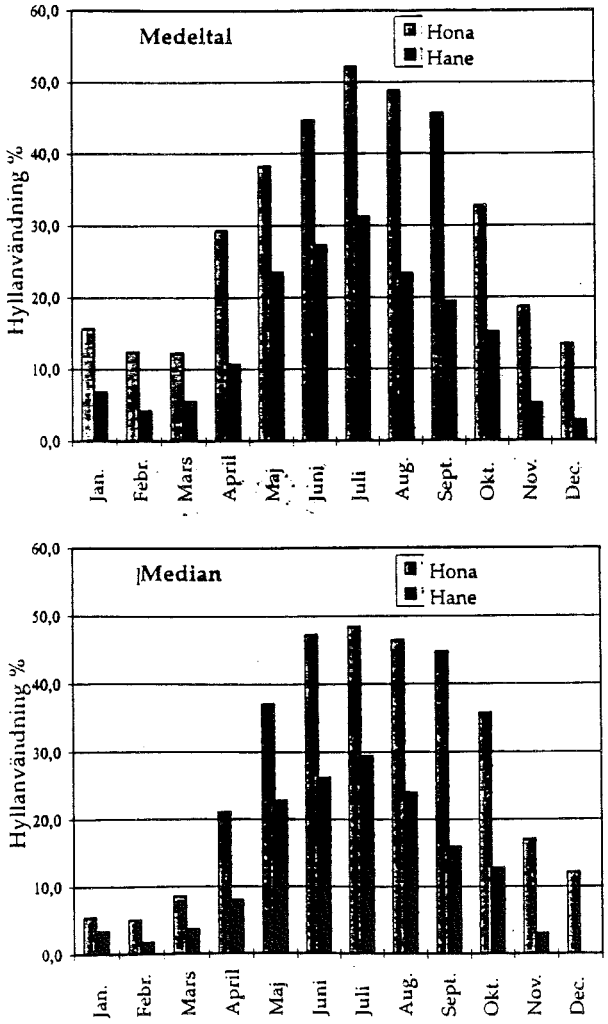

Fig. 2. The use of shelves by full-grown silver foxes (28 ♂, 28 ♀) in different months of the year 1994.

Finsk Pälstidskrift 30, 1-2, pp 24-25, 1996. In SWED. 1 table, 2 figs., 1 photo, 6 refs. CAB-abstract.

Ways to improve skin production

Jerzy Slawon

It is estimated that the quantity of fox skins produced in Poland is approximately 370,000. Such a production enables us to consider Poland as the one of the largest suppliers of fox skins in the world. However, an alarming decrease in skin quality has been observed in the last years. In the 1993/1994 season, lower prices (by about 50%) were paid for Polish skins at the international auction sales than for Scandinavian skins. Therefore, Poland becomes less and less competitive in the world market. It is, therefore, necessary to determine the causes of this situation and to counteract them.

A comparative analysis of Polish skins with Finnish ones indicates that the lower prices paid for the Polish fox skins are mainly due to their smaller size and coat structure. These features are responsible for over 80% of the price difference. The author assumes that inadequate nutrition, low effectivity of breeding and non-compliance with technological regime are responsible for this situation. To improve breeding effectivity, it is proposed:

- changes of the compulsory rules concerning the selection of animals and breeding assessment of the herds,
- rational use of imported breeding material,
- application of artificial insemination in fox reproduction.

In the field of nutrition the following is necessary:

- wide introduction of strict standarization of nutrition realized by the opening of consultation centres and use of computer nutrition programs,
- experimental design of the optimum nutrition rations based on regional supply and prices of the raw feeds,

- start of the appropriate supplementary feed manufacture in the form of concentrated premixes and vitamin-mineral supplements.

Moreover, homogenous treatment of the skins in preparation for sale is urgent.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 9-18, 1994. In POLH, Su. ENGL. 3 tables. Author's summary.

Influence of some factors on the variation in coat colour of nutria

Ryszard Cholewa

The aim of the investigation was to determine the influence of season, litter size, origin and effect of different mating on the variation in coat colour of nutria. The investigations were carried out on the nutria farm P-18 at Steszew near Poznan, belonging to Ireneusz Urbaniak. In the years 1988-1989 hair samples were taken from the middle of the hind part of the right side in females and males of Greenland and Steel-silver breeds and their crossbreds kept in pens under a pavilion. The Momcolor apparatus was used for colour measurements.

Photometric lightness was the most differentiating indicator of colour (Y%). It was used as a proper index characterizing the coat colour in the animals estimated.

The evaluation of the coat colour in nutrias of both breeds and sexes was carried out in summer, autumn and winter. The effect of litter size on coat colour was found only in Greenland nutrias born in litters of various size when the colour lightness was compared. In a similar way, the author characterized the types of crossbred animals comparing them with the parental breeds. Neither season nor litter size influenced the lightness of coat colour.

There were, however, marked differences in this respect between the Greenland and Steelsilver nutrias as well as their crossbred progeny.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 29-33, 1994. In POLH, Su. ENGL. 1 table, 8 refs. Author's summary.

Accuracy of external trait evaluations of chinchilla

Grazyna Jezewska, Danuta Dabrowska, Janusz Maciejowski, Grzegorz Niezgoda

Four candidates to become licenced chinchilla judges underwent a test. The candidates were to evaluate the same five animals three times, the animals being presented in a sequence unknown to them, to give the impression of 15 animals being evaluated. The animals were also evaluated collectively by the examining board, the results of this evaluation not known to the applicants. Variability components and evaluation repeatability were estimated by means of variance analysis. The results point to faults in the description of the evaluated traits as well as to relatively high divergences between the verdicts given by particular candidates. The experiment proves the usefulness of the assumed form of the test. The ability to repeat one's own evaluation convergent with that of the examining board is the best criterion of the candidate's competence.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 35-43, 1994. In POLH, Su. ENGL. 4 tables, 6 refs. Authors' summary.

The effect of sex and way of blood sampling on acid-base status in polar foxes

Beata Glowinska, Roman Szymeczko, Thomasz Pietryga, Kazimierz Chojnicki

The effect of sex on acid-base status was investigated in 30 adult polar foxes (15 females and 15 males). Acid-base parameters were determined in blood samples collected in

heparinized capillary tubes after claw cutting. The analysis of the results showed that in males the acid-base status was shifted, in relation to females, to the metabolic acidosis.

The influence of the way of blood sampling on acid-base status was tested in 30 polar foxes (males) divided into three groups. In the first experimental group (I) blood samples were collected from the brachial vein in syringes. In the second group (II) samples were assembled in heparinized capillary tubes also from the brachial vein. In animals from the third experimental group (III) the tip of a claw was cut off and blood was collected in capillary tubes. Significant differences in acid-base parameters were found depending on the way of blood sampling.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 51-57, 1994. In POLH, Su. ENGL. 2 tables, 9 refs. Authors' summary.

The influence of collective or individual maintenance of polar foxes on body weight, feed intake as well as on body conformation and pelt quality

Andrzej Filistowicz, Janusz Kuzniewicz, Stanislaw Krzywiecki, Piotr Przysiecki

The influence of collective and individual maintenance of polar foxes during the final period of rearing (from 17 to 26 weeks of life) on body weight, feed intake, estimation of body conformation and pelt quality as well as on the after slaughter pelt evaluation were studied.

The foxes were assigned to control and experimental groups on the basis of analogues in respect of sex, parentage and body weight at weaning.
The system of management had no significant influence on body weight, amount of consumed feed, growth rate, score for body conformation and pelt evaluation. Individual maintenance of foxes visibly improved the pelt quality. The pelt quality of foxes kept in individual cages was highly significantly better in respect of quality classes than pelts of foxes maintained collectively.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 71-81, 1994. In POLH, Su. ENGL. 4 tables, 9 refs. Authors' summary.

Pollution of soil habitat of fur animal farms by growing forms of nematodes

Hanna Bis-Wenzel, Jerzy Slawon, Leon Saba, Krzysztof Tomczuk, Teresa Bombik

For 2 years a research on pollution of the soil by growing forms of nematodes was carried out on five farms with carnivorous fur animals. The soil samples were taken at the centre of the farm, as well as at a distance of 75 and 150 meters beyond its boundaries. The soil samples were examined by the Quinn method. It was found that the soil was polluted either by *Toxocara canis* and *Toxascaris leonina* ova or ova and live larvae of *Uncinaria stenocephala* and *Ancylostoma caninum*. It was concluded that the farms of carnivorous fur animals greatly pollute the soil by the growing forms of nematodes.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 207-212, 1994. In POLH, Su. ENGL. 2 tables, 12 refs. Authors' summary.

Mapping of silver fox genome: IV. Location of ornithine carbamoyltransferase and prion protein genes in chromosomes

I.V. Koroleva, T.M. Khlebodarova, N.B. Rubtsov, S.M. Zakiyan

The location in chromosomes of genes encoding ornithine carbamoyltransferase (ornithine transcarbamylase, OTC) and prion protein (PrP) was determined by Southern blotting of DNAs obtained from a panel of hybrid (fox x Chinese hamster) somatic cell clones, with human *OTC* and Chinese hamster *PrP DNA* fragments used as probes. The gene *OTC* was located in the X-chromosome and *PrP* was located in chromosome 14 of the fox.

Genetika (Moskva), Vol. 30, No. 6, pp 839-842, 1994. In RUSS, Su. ENGL. Authors' summary.

Sex ratio in silver foxes: effects of domestication and the *star* gene

L.N. Trut

The course of changes in secondary sex ratio (proportion of males at birth) in silver foxes bred at the fur farm of this Institute was analyzed. Data collected over several years of breeding of a domesticated (experimental) population selected for amenability to domestication and of commercial (control) were compared. A tendency to increase in secondary sex ratio was demonstrated in both populations. However, the proportion of males at birth was higher in domestic foxes. This proportion, calculated from the combined data for 1978-1993, was 0.538±0.005 and 0.511±0.007 in the selected and commercial populations, respectively. The minimal departure of the observed sex ratio from 0.5 was demonstrated for litters with five pups, which is close to the average litter size in fox populations. The proportion of males increases with both increasing and decreasing litter size. An analysis of secondary sex ratio with respect to maternal age revealed a minimal departure of sex ratio from the expected in offspring from foxes of optimal reproductive age (2-4 years). An effect of the autosomal semidominant coat colour mutation *star* on male excess at birth was also found: secondary sex ratio was higher (0.583±0.015) in offspring of mothers heterozygous for the *star* mutation than from standard types of the domesticated population. The increase in secondary sex ratio in the analyzed fox populations is viewed as a correlated response to selection for domestication. The hormonal mechanisms mediating the effects of both this selection and the *star* mutation on sex ratio at birth are discussed.

Theor Appl Genet 92, pp 109-115, 1996. 6 tables, 3 photos, 33 refs. Author's abstract.

Effects of selection for absence of defensive behaviour with respect to human contact on fetal progesterone in silver foxes

L.V. Osadchuk

Silver foxes bred in captivity show dominance of defensive responses to human contact. Systematic selection for elimination of aggression and fear towards human being (domestic behaviour) produced a population of foxes behaviourally resembling dogs. In the previous investigations it was found that selection of silver foxes for domestic behaviour was associated with a decrease in adrenal cortisol output at the end of fetal life. The aim of this study is to present changes in the fetal progesterone biosynthesis after a long-term selection of silver foxes for domestic behaviour. The adrenal and gonadal progesterone content and serum progesterone level of fetuses from domesticated and control mothers were measured by RIA on days 35, 40, 45 and 50 of pregnancy (term=52). The progesterone adrenal content increased until the peak was reached on day 45 and then decreased on day 50. The adrenal progesterone content was greater on days 45 and 50 in control animals in comparison with domesticated ones. No progesterone was detected by RIA in fetal ovaries and testes. The results show that

progesterone as the main precursor for steroid biosynthesis is produced exclusively by fetal adrenals, and the fetus progesterone level depends mainly on mother's progesterone and/or that secreted by fetus adrenals. The progesterone level decreased progressively in the course of prenatal life in both groups of fetuses, and the changing pattern of fetal progesterone levels was similar to that in their mothers at the same period of pregnancy. There were no significant differences in the fetal progesterone levels between domesticated and control animals while the progesterone level was greater in domesticated mothers than in control ones. It is suggested that selection for domestic behaviour has led to a decrease of the fetal adrenal progesterone output and alterations in the hormonal mother-fetus relationships.

Journal of Endocrinology, Vol. 152, Suppl., pp 269, 1997. Only abstract received. Authors' abstract.

Adrenal function in mink (*Mustela vison*) selected for behaviour

R.G. Gulevich, O.V. Trapezov, L.N. Maslova, A.V. Kharlamova, L.V. Osadchuk

Рис. 1. Влияние иммобилизации на функцию надпочечников у самцов норок, селекционируемых по поведению.

Glucocorticoid function of the adrenals and its reactivity to stress caused by immobilization and to ACTH stimulation have been studied in the male mink selected both for domestic and aggressive behaviour towards man. In the autumn period the regression of cortisol content in the adrenals was observed in domesticated males and particularly in aggressive ones compared with control. In the same period the increased level of cortisol in the blood as the result of immobilization was noticed in aggressive mink compared with the domesticated and control ones. At ACTH stimulation in springtime the increase of cortisol in the blood was shown for animals of all the groups but was more marked in the aggressive ones.

Zhurnal Ehvolyutsionnaj Biochimii i Fiziologii, Russia, 31, 4, pp 444-448, 1995. In RUSS, SU. ENGL. Authors' summary.

Genetic parameters of fur traits and body size in Arctic blue fox (*Alopex lagopus* L.)

Stanislaw Socha

The work aimed at estimation of heritability as well as at genetic, phenotypic and environmental correlations of traits evaluated during appraisal of Arctic blue foxes. Original data from ac reproductive farm covered a period of 9 years. Traits evaluated were: body size, colour type, colour clarity, hair length, external appearance and total score.

Genetic parameters were evaluated from size and dam components and, in addition, from sire and dam variance-covariance components together. Harvey's model 4 for mixed data was applied. Heritability of traits for a given component ranged from 0.156 to 0.505 for body size; from 0.360 to 0.647 for colour type; from 0.050 to 0.605 for colour clarity; from 0.107 to 0.496 for hair density; from 0.134 to 0.672 for hair length; from 0.004 to 0.420 for external appearance; from 0.133 to 0.850 for total score.

The highest heritability values were found when calculated from the dam's component. Genetic correlations ranged from –0.088 to 0.651, phenotypic from –0.206 to 0.556 and environmental from –0.416 to 0.368.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 19-28, 1994. In POLH, Su. ENGL. 3 tables, 13 refs. Author's summary.

Fecundity for the first year performance of Arctic fox females (*Alopex lagopus* L.) on a chosen breeding farm

Stanislaw Socha

The work aimed at evaluation of variability and changes in Arctic fox female fecundity over 12 years. Two traits were examined in each female i.e. number of born and raised cubs. Data collected for the fox females were analysed according to the fur colour and their origin within three groups:

1. Blue native animals from own breeding or purchased from another farm in Poland
2. Blue animals imported or progeny from imported foxes with more than 50% foreign blood.
3. White animals irrespective of origin.

The results can be summarised and concluded as follows:

1. A similar level of variability of traits was found within all groups. In most cages the average number of cubs born was characterised by a smaller coefficient of variation (30 to 40%) than for the number of raised foxes (above 50%).
2. Numbers of born and raised cubs from blue foxes have significantly decreased during the 12 analysed years. Regression coefficients reached values –0.161 and –0.150 for each trait within the group of blue imported females. Regression within the group of blue foxes from native breeding for above-mentioned was –0.142 and –0.094, respectively. No statistically significant relationship was found within the group of white females.
3. The negative changes in fox fecundity could be caused by a negative correlation between reproductive traits and fur traits. Regular selection on fur quality could cause an accumulation of unfavourable polygenes responsible for the decrease in fox fecundity.

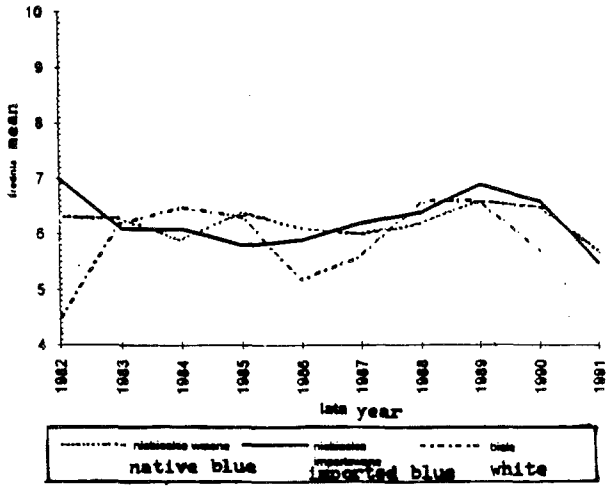

Fig. 2. Mean values of raised cubs per one year old Arctic fox female.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 141-153, 1994. In POLH, Su. ENGL. 4 tables, 2 figs., 15 refs. Author's summary.

An attempt to estimate the relationship between the reproductive results of polar fox females (*Alopex lagopus* L.) and their body weight

Andrzej Frindt, Marian Brzozowski, Robert Glogowski, Danuta Dzierzanowska

The relationship between the course of body weight changes in female polar foxes during the autumn-winter season and their reproductive results (the number of barren females and the number of born and weaned litters) were examined. The investigation involved 89 animals (45 experimental and 44 as control group). Seasonal changes of body weight were found in all animals: the body weight increased during autumn and decreased during winter. Such changes ranged from 0 to over 40%.

The experimental animals were divided into 3 groups according to the last weight (21 II). "light" (under 4.9 kg) – 7 females, "middle" (from 4.9 to 5.7 kg) – 27 females, "heavy" (over 5.7 kg) – 11 females.

It was found that the best reproductive results were obtained in the "heavy" group: 91% whelped and 81% weaned.

It seems that the heaviest females ought to be preferred in breeding animals on the farm.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 165-170, 1994. In POLH, Su. ENGL. 1 table, 2 figs., 8 refs.. Authors' summary.

Developmental changes in testicles during the postnatal period in raccoon dogs

Piotr Niedbala, Olga Szeleszczuk, Stanislaw Jarosz

Studies on developmental changes in testicles in the postnatal period in raccoon dogs were carried out on Chorzelow farm from June 1992 to March 1993.

At the beginning of the month the animals were weighed and blood samples were taken to determine plasma testosterone level as well as the consistensy and testicle size was measured.

During the period from June to January the volume of gonads as well as their weight increased (from 0.16 to 5.33 cm^3) and (from 0.3 g to 5.6 g), respectively.

The consistency of raccoon testicles, as the mating season approached, changed from soft and moderate to hard and very hard.

Single spermatocytes were already noticed in August, however, a true increase of spermatogenesis was found in September. A full process of spermatogenesis occurred in the testicles of raccoon dogs before the mating season.

The highest plasma testosterone level (16 mmol/l) was attained by males in January i.e. a month before the mating season.

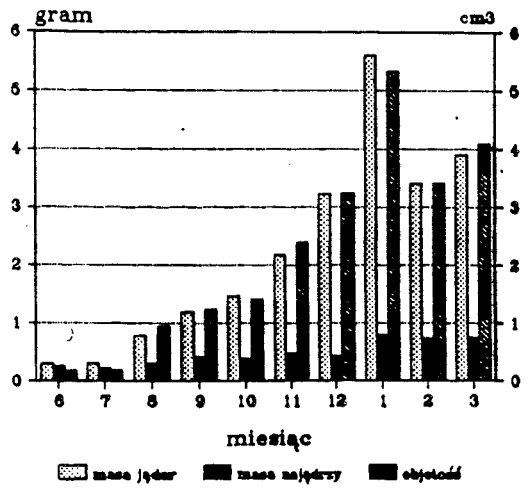

Fig. 2. Testicles and epididymis size in raccoon dogs during the postnatal period

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 171-176, 1994. In POLH, Su. ENGL. 1 table, 4 figs., 9 refs. Authors' summary.

The length of the utilization period and the reproductive results in ferrets

Grazyna Jezewska, Janusz Maciejowski, Grzegorz Niezgoda

It was stated, as a result of a several years' observations, that ferret females were used for reproduction up to 4 years, and males to 5 years. The best reproductive results were obtained in two year old females, however these results were only slightly better than those of one year olds.

A considerable decline in fecundity was observed from the third year onward. The results obtained point out that a 2 year period of utilization seems to be the optimum for fitch females. A relatively high stock replacement rate in such a system of utilization does not affect negatively the productivity results since, on the one hand, the high fecundity of the species makes a strict selection possible and, on the other, the results of reproduction and wea-

ning rates in one year old females turned out to be very good in the following years.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 177-184, 1994. In POLH, Su. ENGL. 3 tables, 1 fig., 7 refs. Authors' summary.

Age at first parturition of Polish and Danish chinchilla females

Malgorzata Sulik

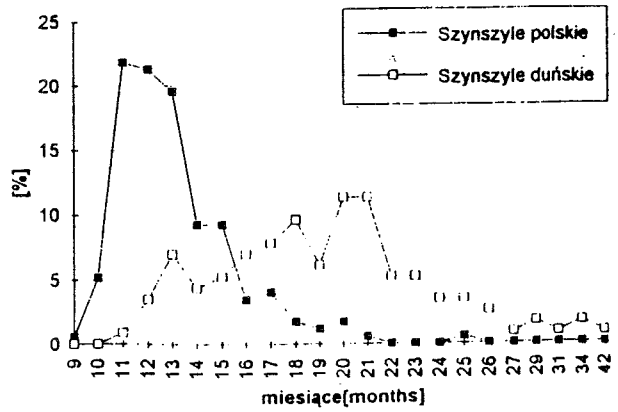

Fig. Age of the chinchilla females at their first parturition

The time of the first litter delivery in standard chinchilla females of Polish and Danish origin was examined. The investigation included 289 females: 174 Polish and 115 Danish. They had 818 young (390 Polish, 228 Danish).

Polish females delivered their first litters at the age of 9-25 months and Danish females at the age of 11-34 months. The majority of Polish females had their young at the age of 11-13 months (62.65%) while Danish females at the age of 18-21 month (38.25%), respectively. The litter were mostly composed of two young (41.95% of Polish females litters and 46% of the Danish ones). Viability of the young reached approximately level on both farms. Mortality of the young Polish females averaged 20,78% and 25.87% in the Danish ones.

Early utilization of chinchilla females for reproduction reduced the age at 1st litter. The higher age at 1st parturition in the group of Danish females were above all connected with their delayed utilization for reproduction, which was caused by the purchase of animals with a mature fur coat at the age of 8-12 months.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 185-191, 1994. In POLH, Su. ENGL. 2 tables, 1 fig., 7 refs. Author's summary.

Application of Spermac® staining for estimation of frozen semen morphology of Arctic and common foxes

Olga Szeleszczuk, Wenche K. Farstad, Jan A. Fougner

Although the first trials with insemination in reproduction of foxes were started in 1934 it was as late as in 1980 that they were introduced on a larger scale, mostly to Scandinavian fox farms. One of the problems difficult to solve was the lack of diagnostic methods enabling full estimation of fresh and frozen semen.

The aim of this study was to evaluate the usefulness of the staining method with Spermac® for determination of the state of the acrosome in the process of freezing and thawing the semen of polar and silver foxes.

Studies were conduced on a total of 74 ejaculates, obtained through masturbation from 16 polar and 18 silver foxes. Semen was diluted with diluent TRIS supplemented with 20% egg yolk and 5% glycerol up to a final concentration of 150 million sperm in 1 ml. After cooling and equilibration the semen was frozen in 0.5 ml straws in liquid nitrogen (Planer Kryo 10). Straws with semen were thawed through dipping for 8 sec. in water at 70°C. Directly after thawing the spermatozoa motility was estimated and semen smears by the Spermac® method (Oettel, 1977), modified by the authors, were made.

In the smears stained by this method the acrosome, midpiece and tail attained a dark-

green colour, the equatorial region turned pale-green while the subacrosomal material and head turned pink.

The process of acrosome impairment was connected with a very distinct change in the intensity of its colour and shape. A high correlation was found between sperm motility after thawing and a degree of acrosome impairment. For the sperm with intact acrosome the correlation coefficient was 0.76.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 223-224 (poster), 1994. In POLH, Su. ENGL. Authors' summary.

Morphological and biochemical changes in nutria semen during conservation with diluents at various glycerol levels

Olga Szeleszczuk, Stanislaw Jarosz, Piotr Niedbala

Studies on morphological and biochemical changes in nutria semen during the process of freezing were conducted on 19 males of Greenland and Standard varieties.

Semen was collected by the electroejaculation method elaborated by Jarosz-Szeleszczuk, allowing us to obtain semen not subjected to gelatinization. For diluting a diluent TRIS with various levels of glycerol was used: 4% (RI), 6% (RII) and 10% (RIII). Equilibration was performed by placing the cooled semen for 1 hr in the cooler, with subsequent freezing, using the MINITUB system. Straws were thawed by dipping them for 8 sec. in water at 70°C.

The course of the freezing and thawing processes was monitored and simultaneously the sperm motility and a morphology as well as the levels of AspAT and AlAT in semen plasma were determined.

The sperm motility in fresh semen, estimated at 53.72% after thawing, decreased to 40.83% in RI, 43.05% in RII and 33.29% in RIII. Statistically significant differences ($P<0.001$) were found between the RIII diluent (with 10% of glycerol) and both: RI and RII (with 4 and 6 % glycerol).

The greatest numbers of sperm cells with a correct morphology (82.3 and 79.9 · %, respectively) were found in the semen smears diluted with RI and RII.

The lowest activity of AspAT and AlAT was found after thawing semen using RI (2.112 and 1.805 μm/ml), a higher one with RII (2.538 and 1.988 μm/ml) and RIII (2.463 and 2.155 μm/ml).

The TRIS diluent with a 6% supplement of glycerol proved the most useful for freezing since it decreased to a least degree the percentage of spermatozoa with progressive motility.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 225-226 (poster), 1994. In POLH, Su. ENGL. 3 tables. Author's summary.

Dietary protein supply to mink (*Mustela vison*) Effects on physiological parameters, growth performance and health

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New doctor in the family. We comgratulate Dr. Birthe M. Damgaard with the title and the fine work which is the basis for it all.

In the present investigation the effects of different dietary levels of protein and essential amino acids on physiological parameters, growth performance and health were investigated in growing mink.

Effects of dietary protein levels of 20% and 45% of metabolizable energy (ME) were investigated in male mink kits during the growing-furring period from July to pelting in December. Hepatic fatty infiltration, plasma activitites of alanine-aminotransferase (ALAT), plasma concentrations of some clinical-chemical parameters, hematological parameters and weights of liver and body were studied.

Effects of dietary protein levels of 15%, 20%, 25%, 30% and 35% of ME were investigated in male mink kits during the growing-furring period from July to pelting in December. Furthermore, the effects of a low protein diet (15% and 20% of ME from protein) supplemented with essential amino acids to meet the estimated requirements in growing mink were investigated. Mortality rate, hepatic fatty infiltration, growth performance, weights of body and liver, hematrocrit values, plasma activities of ALAT and plasma concentrations of some clinical-chemical parameters were studied.

Finally, effects of dietary arginine levels of 1.2%, 1.7% and 2.2% of dry matter (DM) and excess dietary lysine were investigated in male mink kits in the growing period during 4 weeks in July-August. Urinary excretion of orotic acid, growth performance, feed consumption, plasma concentrations of ammonia (NH_3), orotic acid, citric acid, glucose, urea, creatinine and total protein were studied.

Based on results from the investigations, it is concluded that mink have a high requirement for dietary protein besides essential amino acids, especially glucogenic amino acids. The dietary protein level affected the incidence of hepatic fatty infiltration. Low dietary protein levels caused increased mortality rate, hepatic fatty infiltration, increased plasma activities of ALAT and reduced growth performance. Plasma activity of ALAT was found to be a useful tool in estimation of the incidence of hepatic fatty infiltration. The plasma concentrations of total protein, urea creatinine and bile acids and the hemotocrit values were influenced by the dietary protein level. A dietary supplement of essential amino acids to a low protein diet to meet the estimated requirements in growing mink did not improve health, but had a positive effect on growth performance compared with the unsupplemented low protein diet. Arginine is an essential nutrient for mink kits in the growing period and excess dietary lysine antagonizes arginine. In the early intensive growth phase, an arginine supply of 2.2% of

DM (8.0 g/16 g N) resulted in minimum urinary excretion of orotic acid and a supply of 1.7% of DM (6.4 g/16 g N) supported growth performance and prevented increased plasma concentrations of NH_3.

The dietary protein supply to mink in the growing-furring period is proposed to be at least 30% of ME to support normal growth performance and to ensure a low mortality rate. Also in the early intensive growth phase, a dietary protein content of at least 30% of ME in a diet composed of traditional feed ingredients was concluded to meet the arginine requirement needed to support normal metabolism of nutrients.

Ph.D. thesis, 31 pp, 59 refs, 1997. DIAS, Dept. of Animal Health and Welfare, Research Centre Foulum, P.O. Box 50, DK-8830 Tjele, Denmark.

The thesis is based on the following IV reports:

I Damgaard, B.M., Clausen, T.N. & Henriksen, P. 1994. Effect of protein and fat content in feed on plasma alanine-aminotransferase and hepatic fatty infiltration in mink. J. Vet. Med. A. 41, 620-629. *SCIENTIFUR, Vol. 19, No. 4, pp 309, 1995.*

II Damgaard, B.M., Clausen, TN. & Dietz, H.H. 1997. Effect of dietary protein levels on growth performance, mortality rate and clinical blood parameters in mink (*Mustela vison*). Acta Agric. Scand. Sect A, Animal Sci. Accepted for publication.

III Damgaard, B.M., Clausen, T.N. & Børsting, C.F. 1997. Effects of dietary supplement of essential amino acids on mortality rate, liver traits and blood parameters in mink (*Mustela vison*) fed low protein diets. Acta Agric. Scand. Sect. A, Animal Sci. Submitted for publication.

IV Damgaard, B.M. 1997. Effects of dietary supply of arginine on urinary orotic acid excretion and blood parameters in growing mink (*Mustela vison*) kits. Acta Agric. Scand. Sect. A, Animal Sci. Submitted for publication.

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Effect of dietary protein levels on growth performance, mortality rate and clinical blood parameters in mink (*Mustela vison*)

Birthe M. Damgaard, Tove N. Clausen, Hans Henrik Dietz

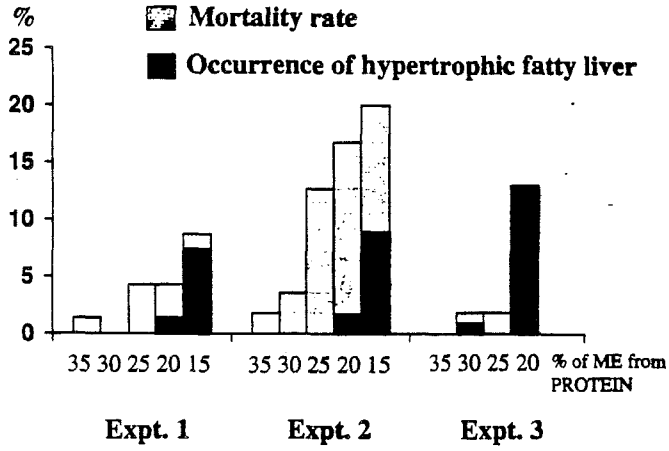

Fig. 2. Mortality rate (%) and occurrence of dead males with hypertrophic fatty liver (%) in the experimental groups at different dietary levels of metabolizable energy (ME) from protein in Expts. 1, 2 and 3.

Effects of dietary protein levels ranging from 35% to 15% of metabolizable energy (ME) and dietary fat levels ranging in a reciprocal fashion from 47% to 67% of ME, and a constant dietary carbohydrate level of 18% of ME were investigated in male mink kits in the growing-furring period. Growth performance, mortality rate, hepatic fatty infiltration, weights of body and liver, relative weight of liver, hematocrit values, plasma activities of ALAT, ASAT and CK, and plasma concentrations of chemical parameters were studied. A protein supply of 30% of ME supported normal growth performance and ensured a low mortality rate. Plasma ALAT and hepatic fatty infiltration increased with decreasing ME from protein.

ALAT was found to be a useful tool in estimation of the incidence of hepatic fatty infiltration. The hematocrit values and the plasma values of total protein, urea, creatinine and bile acids were influenced by the dietary protein level.

Ph.D. thesis, DIAS, Research Centre Foulum, P.O Box 50, DK-8830 Tjele, 1997. Paper II, 22 pp, 2 tables, 3 figs., 25 refs.

Effects of dietary supplement of essential amino acids on mortality rate, liver traits and blood parameters in mink (*Mustela vison*) fed low protein diets

Birthe M. Damgaard, Tove N. Clausen, Christian F. Børsting

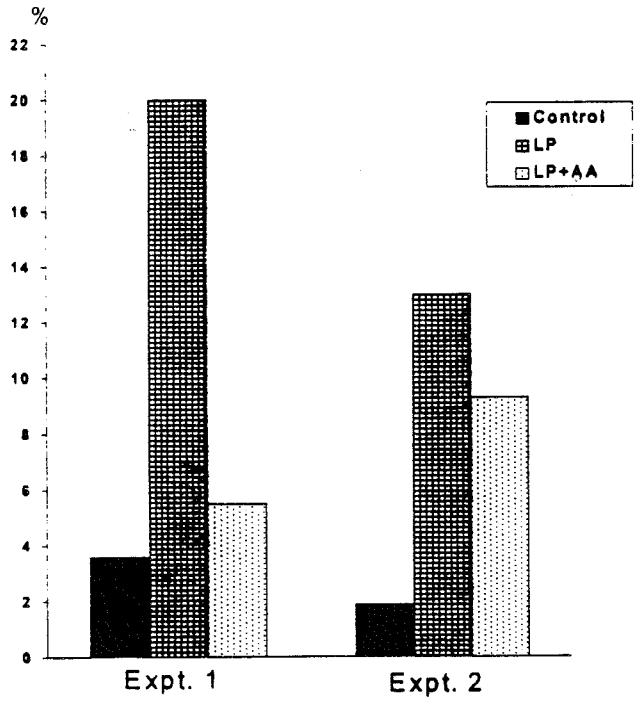

Fig. 2. Mortality rate (%) for males fed a control diet (Control), a low protein diet (LP) and a low protein diet supplemented with essential amino acids (LP + AA) in Expts. 1 and 2.

Effects of low protein diet supplemented with essential amino acids to meet the estimated requirements in mink were investigated in male mink kits during the growing period from weaning to pelting. Mortality rate, liver fat content, liver weights, growth performance, plasma activities of alanine-aminotransferase (ALAT), plasma concentrations of total protein, urea, creatinine and bile acids and hematocrit values were studied. The results showed that the mink has a high requirement of dietary protein besides essential amino acids, especially glucogenic amino acids. Feeding a low protein diet caused increased mortality rate, liver lipidosis, increased plasma activity of ALAT and reduced growth performance compared with control feeding. A dietary supplement of essential amino acids to the low protein diet did not improve the health status, but had a positive effect on growth performance compared with the unsupplemented low protein diet.

Ph.D. thesis, DIAS, Research Centre Foulum, P.O Box 50, DK-8830 Tjele, 1997. Paper III, 17 pp, 4 tables, 2 figs., 22 refs.

Effects of dietary supply of arginine on urinary orotic acid excretion and blood parameters in growing mink (*Mustela vison*) kits

Birthe M. Damgaard

Effects of dietary arginine levels of 1.2%, 1.7% and 2.2% of dry matter (DM) (4.8 g/16 gN, 6.4 g/16 g N and 8.0 g/16 g N, respectively) and excess dietary lysine were investigated in male mink kits in the growing period during 4 weeks in July-August. Urinary excretion of orotic acid, growth performance, feed consumption, plasma concentrations of ammonia (NH_3), orotic acid, citric acid, urea, glucose, total protein and creatinine were studied. The results showed that arginine is an essential nutrient for mink kits in the growing period and that excess dietary lysine antagonizes arginine. An arginine supply of 2.2% of DM 88.0 g/16 g N) resulted in minimum urinary excretion of orotic acid and a supply of 1.7% of DM (6.4 g/16 g N) supported growth performance and prevented increased

plasma concentrations of NH_3. The plasma concentrations of orotic acid, citric acid, urea, glucose, total protein and creatinine were not affected by the dietary levels of arginine.

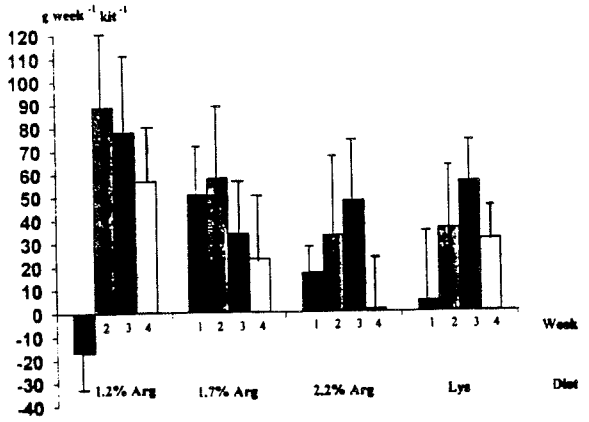

Fig. 1. Body weight gain (g week^{-1} kit^{-1}) in mink kits fed 1.2% arginine (1.2% Arg, n=10), 1.7% arginine (1.7% Arg, n=10), 2.2% arginine (2.2% Arg, n=9) and excess lysine (Lys, n=10) in experimental weeks 1-4. Values are means±SEM.

Ph.D. thesis, DIAS, Research Centre Foulum, P.O Box 50, DK-8830 Tjele, 1997. Paper IV, 24 pp, 5 tables, 2 figs., 35 refs.

Lymphatic absorption of *n* – 3 poly-unsaturated fatty acids from marine oils with different intramolecular fatty acid distributions

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

Male Wistar rats were given 0.5% ml of either fish oil or seal oil intragastrically. The intramolecular fatty acid distributions of the triacylglycerols administered were determined by non-specific Grignard degradation followed by isolation and analysis of the 2-mono-acylglycerols. The *n* – 3 polyunsaturated fatty acids (PUFAs), especially eicosapentaenoic acid (20:5 (*n* – 3)) and docosahexaenoic acid (22:6 (*n* – 3)), were located in outer positions (*sn*-1/3) in the seal oil triacylglycerols whereas the *sn*-2 position of fish oil triacylglycerols was enriched in 20:5 (*n* – 3) and 22:6 (*n* – 3). The mesenteric lymph was collected over the following 24 h and the absorption patterns of *n* – 3 PUFAs were determined. In the lymph, the *n* – 3 fatty acids characteristic of the marine oils rapidly increased both with regard to mole percentage and transport (μg/min). There were, however, no overall significant differences in the absorption patterns over 24 h period. The ratio between mole percentage in the oil and mole percentage in the lymph calculated at the steady-state period was significantly greater for both 20:5 (*n* – 3) and 22:6 (*n* – 3) following fish oil administration compared with seal oil. Initially, the recovery on *n* – 3 PUFAs as a percentage of the total amount transported over the experimental period was higher following injection of fish oil than seal oil but seal oil resulted in greater recovery in the last two fractions at 8 and 24 h post injection, respectively. This indicated that *n* – 3 PUFAs from fish oil may have been better absorbed in the initial period of digestion but overall the structure of dietary triacylglycerols had negligible effects on the assimilation of *n* – 3 PUFAs when these were administered as native marine oils.

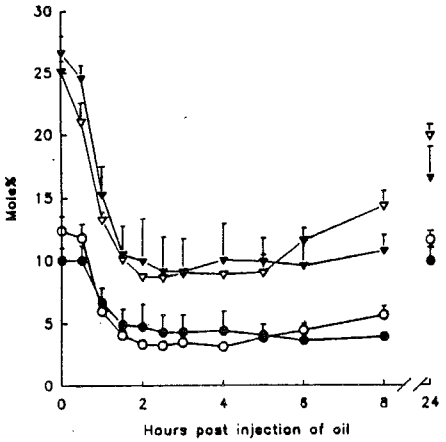

Fig. 4. The time course of the mole percentage of endogenous fatty acids (fatty acids characteristic of the lymph at baseline level) in mesenteric lymph following intragastric administration of oils. Mole percentage of linoleic acid (18:2(*n* – 6)) following administration of fish oil (▽–▽) and seal oil (▼–▼) and arachidonic acid (20:4(*n* – 6)) following administration of fish oil (○–○) and seal oil (●–●). The data represent mean ± S.E. for 7 and 6 animals for the fish oil and seal oil, respectively.

Biochimica et Biophysica Acta 1215, pp 198-204, 1994. 2 tables, 5 figs., 48 refs. Authors' summary.

Utilization of egg products in mink nutrition. Nutrient content and digestibility

He Jianhua, D.M. Anderson, Kirsti Rouvinen

Egg was used in mink production as a protein source to reduce the feed cost, but raw egg contains an antinutritional factor known as avidin. In the present study the nutrient content of six egg products was analyzed and the effect of heat on the nutrient digestibility of egg was investigated. Twelve male mink of six months of age were used in a Latin square experiment to evaluate the utilization of six egg products: powdered eggs (PE, commercial products), raw egg with shell (RWS, crushing before mix with other feed ingredients), raw egg without shell (RWOS), boiled egg with shell (BWS, boiling for 10 minutes after the water was boiling), boiled egg without shell (BWOS) and fried egg (FG, fried for 3-5 minutes at 300 °C with stainless fry pan). The digestibility of dry matter, crude protein, fat, carbohydrate and gross energy were determined by the index method (Cr_2O_3). The result showed that protein and fat of egg products were highly digestible for mink, it also indicated that boiling had no significant effect on the crude protein digestibility of egg products in mink ($P>0.05$), but boiling decreased the digestibility of fat and gross energy significantly ($P<0.05$), frying can significantly improve the crude protein digestibility of egg without shell ($P<0.05$). Based on the results of the present study, RWS was recommended to use in the practice of mink production at a rate of 15%.

Acta Zoonutrienta Sinica (China), Vol. 7, 1, pp 10-14, 1995. 4 tables, 8 refs. Authors' summary

Distribution of digestive enzymes along the small intestine in blue fox, mink and ferret

Victor M. Oleinik

The activity of amylase, total proteases, monoglyceride lipase, glycil-leucine dipeptidase and sucrase were investigated in mucosa from five consecutive parts of the small intestine in blue fox, mink and ferret. The spatial distribution of enzyme activity was found to depend on food transit rate, diet composition and individual peculiarities of animals. A high level of activity of some digestive enzymes in the distal parts of the intestine is characteristic for predatory fur animals. Probably this fact can be considered as an adaptive-compensatory reaction to farm diet.

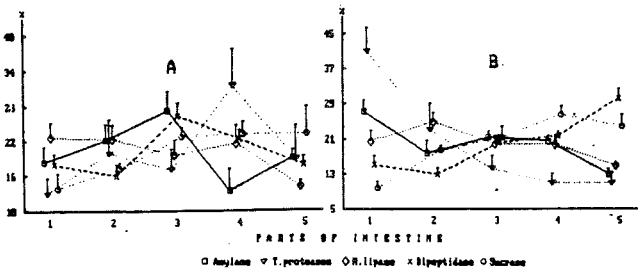

Fig. 1. Digestive enzyme activity in mucosa of different parts of small intestine in blue fox. Along the Y-axis – average activity in per cent of summary activity of all parts ± SE. A, B – experiments 1, 2

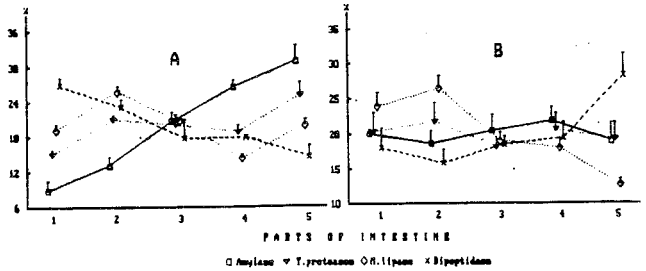

Fig. 2. Digestive enzyme activity in mucosa of different parts of small intestine in mink. The designations are the same as in Fig. 1

On the basis of the present experiments, it can be concluded that the rate of the passage of food along the gastro-intestinal tract in predators is higher than in other animals. Due to the high rate of food transit in predators, there is probably no time for sufficient food hydrolysis in the proximomedial parts of the small intestine, which is why in the distal part of it there are many substrates for the effect of digestive enzymes. Distal parts of the intestine are on the average at least not less active than proximomedial ones. The data by Szymeczko,

Skrede on the high protein digestibility in distal parts of mink intestine serve as its confirmation.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 45-56, 1994. In ENGL. 3 figs., 11 refs. Summary: G.Jørgensen.

The effect of B_{12}-vitamin and methionine supplemented diet on blood level of B_{12}-vitamin and license estimation in polar foxes

Romuald Rajs, Tomasz Bednarek

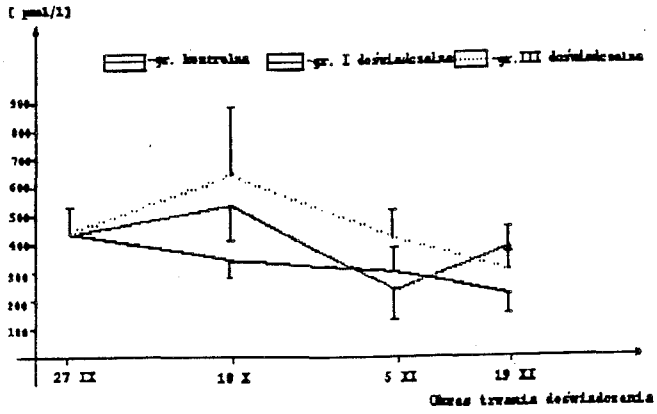

Fig. 1. The changes in blood level of B_{12}-vitamin (pmol/l) in polar foxes

The experiment was carried out in autumn, from September to November, on 64 polar foxes. The animals were divided into 4 groups: three experimental groups and a control one. Experimental animals from the 1st group were periodically injected with B_{12} vitamin. Foxes of the 2nd group were fed a diet supplemented with 0.2% methionine. Animals from the third experimental group were periodically injected with B_{12}-vitamin and fed a diet containing methionine. In foxes from the first experimental group, higher blood level of B_{12}-vitamin and improvement of colour, density and pelt structure compared with control animals, were found. The foxes fed a diet with methionine had better fur density than control animals. Animals treated jointly with B_{12}-vitamin and methionine were characterized by worse colour and pelt structure than foxes from the control group.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 83-89, 1994. In POLH, Su. ENGL. 2 tables, 3 figs., 8 refs. Authors' summary.

Activities of some enzymes in the blood plasma and different tissues of mink fed a diet supplemented with preserved or boiled beef blood

Tomasz Pietryga, Dariusz Frelichowski

The experiment was carried out in two stages. The experimental animals were 80 mink of the standard type. The aim of the study was to estimate the effect of different systems of feed conservation, as well as diet composition on activities of some enzymes in the blood and selected tissues of mink. Analysis of the results did not indicate any significant differences on plasma and tissue enzyme activities between animals fed differently preserved feed. Thus, it was concluded that conservants tested in the experiment did not cause any negative changes in tissues and organs examined.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 91-98, 1994. In POLH, Su. ENGL. 8 tables, 9 refs. Authors' summary.

Duration of preliminary and experimental periods in digestibility experiments in polar foxes

Roman Szymeczko, Zbigniew Podkowka

The experiment was carried out at the Animal Physiology Department, Academy of Technology and Agriculture in Bydgoszcz. The experimental animals were six male polar foxes (6.8 ± 0.3 kg) kept individually in metabolic cages. The aim of the study was to determine the duration of the preliminary and experimental periods in digestibility investigations. To this effect apparent digestibi-

lity of nutrients were estimated in foxes fed diets with different sources of protein (cod fish and fish meal). The highest differences for the apparent digestibility of dry matter, nitrogen, fat and amino acids were found during the first 3 or 4 days of the study. In last 4 days the differences were less distinct. It has to be pointed out that during the experiment no significant differences ($p>0.05$) in apparent digestibility of dry matter, nitrogen and fat were noted. Presented results proved the usability of 4 day preliminary and experimental periods in digestibility experiments in polar foxes.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 99-107, 1994. In POLH, Su. ENGL. 6 tables, 11 refs. Authors' summary.

Influence of supplement with milk replacers on some traits of raw nutria skins

Ryszard Cholewa, Slawomir Nowicki

The experiment was carried out on 210 Standard nutrias 12 weeks old of both sexes. They were fed diets with a supplement of milk powder and Serwal in part I and with milk powder and casein in part II in doses of 3 g/animal daily during the first half in each part of the experiment and 6 g/animal in the second half. In the skin of 163 nutrias, slaughtered when 33 weeks old in the first part and at age 30 weeks in the second part, the evaluation included measurements of weight, thickness, length, height of overcoat and of underfur, SGM measurements and the quality class.

In the first part of the experiment the males and females fed diets with the supplement of milk substitutes had longer skins than the control animals. The hairs in both coat layers were shorter and the SGM measurements had higher values. The skins of males were heavier, while those of females obtained better quality class. In the second part of the experiment the differentiation in skin and coat traits was less pronounced. In the females the skins and coats were more similar in the analysed traits but in the coats and skins of males fed milk substitutes considerable differentiation was observed. Their skins were heavier, thicker, SGM-readings were higher and their quality was better than of those from control animals.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 109-115, *1994. In POLH, Su. ENGL.* 1 *table, 7 refs. Authors' summary.*

Use of complete pelleted mixtures in chinchilla feeding

Boguslaw Barabasz

The aim of this study was to discuss the feeding requirements of chinchilla and to compare pelleted mixtures for these animals, produced in Poland and abroad. The following pelleted mixtures were selected for investigation: 3 granulated mashes currently produced in Poland, 3 granulated mashes, considered as good mixtures, but no longer produced in Poland and 8 foreign granulated mashes, produced on commercial scale in Denmark, Germany and Czech Republic.

All of them contained 10-15 components, including 20-63% barley sprouts and maize, 3-12% extracted meals, 22-40% green fodder meals, 10-21% wheat bran, 2-12% animal by-products meal. A good pelleted food for chinchilla should be characterized as follows:

- multicomponent, which affects nutritive value and palatability
- crude protein content estimate at 16-18%, fat 2-5%
- with an indispensable supplement of mineral-vitamin premix and dry herbs.

Anim. Prod. Rev. (Poland). Appl. Science Reports 15, pp. 125-132, *1994. In POLH, Su. ENGL.* 3 *tables, 9 refs. Author's summary.*

Transmissible mink encephalopathy

D. McKenzie, J.C. Bartz, R.F. Marsh

Transmissible mink encephalopathy is a rare disease of ranch-raised mink that is caused by exposure to a scrapie-like agent in feed. Transmission of TME to hamsters resulted in the identification of two clinically different syndromes, HYPER and DROWSY. Differences in the physiochemical properties of PrP from these two strains suggests that PrP plays an important role in defining strains. This review will summarize what is currently known about TME and relate it to the broader field of transmissible spongiform encephalopathies.

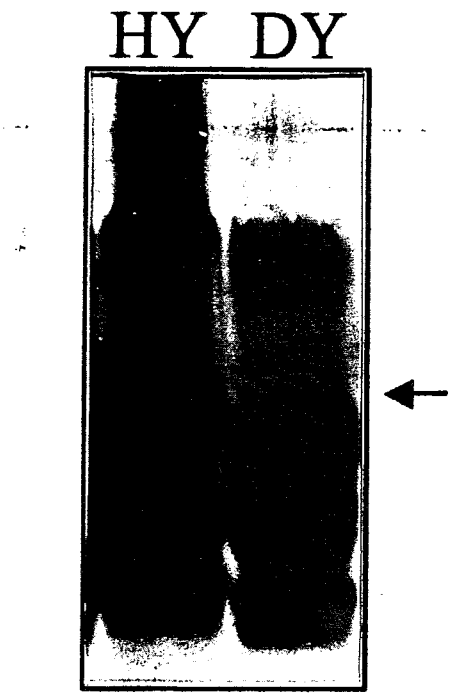

Figure 1. Western blot of proteinase K digested PrP^{TME} from hamsters infected with HY and DY strains of the agent. PrP^{TME} was prepared using standard methods and digested for 1 hour with 100 µg/ml proteinase K at 37°C. The samples were then fractionated on SDS-PAGE gels, transferred to Immobilon P and reacted with the anti-PrP antibody 3F4. The arrow indicates the location of the 29 kDa protein marker.

Seminars in VIROLOGY, Vol. 7, pp 201-206, 1996. 1 fig., 48 refs. Authors' abstract.

A simple touch-down polymerase chain reaction for the detection of canine parvovirus and feline panleukopenia virus in feces

Barbro Schunck, Wilfried Kraft, Uwe Truyen

A polymerase chain reaction (PCR) assay is described for the detection of parvovirus in feces of dogs and cats. A touch-down protocol was used which enabled the specific amplification of virion DNA from feces after a fast and simple boiling pretreatment. The sensitivity of PCR was as high as ten infectious particles per reaction which corresponds to a titer of about 10^3 infectious particles per gram of unprocessed feces. This renders the PCR about 10- to 100-fold more sensitive than electron microscopy, the standard method for parvovirus diagnosis. The very rapid and simple sample preparation recommends this PCR assay as an alternative technique for routine parvovirus diagnosis.

Fig. 1. Localization of the primers in the genome of canine parvovirus. The primers hybridize to DNA sequences within the capsid protein gene (VP2). The start of the open reading frames for the large non-structural protein NS1, and for the capsid protein VP2 are indicated by arrows.

Journal of virological Methods 55, pp 427-433, 1995. 3 tables, 2 figs., 23 refs. Authors' abstract.

Polymerase chain reaction assays for the detection of canine and feline parvoviruses in feces

B. Schunk, U. Truyen

Polymerase chain reaction (PCR) assays for the detection of parvovirus in feces of dogs and cats were developed as fast and simple diagnostic methods. PCR has proven to be a valuable alternative to the laborious and often

insensitive methods currently used for routine parvovirus diagnosis although initially it had to overcome problems with substances in feces inhibiting enzyme activity. Various methods have been described to reliably eliminate or inhibit these factors, as boiling, phenol chloroform extraction, or chromatography. The sensitivity of PCR was described as high as ten infectious particles per PCR reaction which corresponds to a titer of about 10^3 infectious particles per gram unprocessed feces. This renders PCR about 10 to 100-fold more sensitive than electron microscopy, the current standard method for parvovirus diagnosis. This review summarizes different published approaches of various groups in the development of PCR assays as routine parvovirus diagnostic tests.

FIGURE 1. — Negative staining electron microscopy of canine parvovirus in fecal material. Bar represents 50µm.

Revue Méd. Vét. 147, pp 109-110, 1996. 2 figs., 15 refs. Authors' summary.

Eradication of *Otodectes cynotis* infection in farmed blue and silver foxes (*Alopex lagopus* and *vulpes vulpes*) with ivermectin in the feed

Bjørn Gjerde, Harald Holm

All foxes in six fox farms (978 animals) were treated against *Otodectes cynotis* orally with ivermectin mixed into the standard wet feed. Each fox received about 5.5 mg ivermectin (≈0.5 mg/kg body weight) daily on days 0, 1, 9 and 10. Animals refusing to eat the medicated feed were given a dose of 0.3 mg ivermectin/kg body weight subcutaneously on days 2 or 11. Cotton swabs from both ears of about 10% of the foxes in each farm were collected before and after treatment and examined for *O. cynotis*. Before treatment 86 of 98 animals examined (88%) had *O. cynotis*. None of 97 animals examined 15 days posttreatment (day 25) had live *O. cynotis*, but 27 foxes carried dead mites. No live *O. cynotis* were detected in any of 92 foxes examined 31-32½ weeks posttreatment, but one fox carried two dead mites, which had probably been dead since treatment. Thus the oral treatment with ivermectin in the feed seemed to eradicate *O. cynotis* completely from the farms. This kind of treatment is less time-consuming to the owner and causes less stress to the foxes than individual local or parenteral treatment against *O. cynotis*. To eradicate *Otodectes cynotis* from a fox farm, all foxes should be given ivermectin in the feed for two consecutive days twice about 14 days apart.

Norsk Veterinærtidsskrift 108, 2, pp 75-81, 1996. In NORG, Su. ENGL. 2 tables, 13 refs. Authors' summary.

Efficacy of phoxim administered in the ears against *Otodectes cynotis* in farm foxes

Harald Holm, Bjørn Gjerde

All foxes in three fox farms (288 animals) were treated against the ear mite *Otodectes cynotis* twice with an interval of 14 days with 37.5 mg of phoxim (0.5 ml of Sebacil® pour on) in each ear. Some foxes from each farm were examined for ear mites (by cotton swabs) and otitis externa once before treatment and twice posttreatment. Before treatment 24 of 31 foxes examined (77%) were infected with *O. cynotis*. Three weeks post treatment none of 59 animals examined had live *O. cynotis*. Eight months posttreatment 5 of 58 animals examined (9%) had live *O. cynotis* (1-2 mites per animal). In one of the farms all foxes were still uninfected. Phoxim administered in the ears may not have killed ear mites living in other areas of the body, but a reinfection after treatment cannot be excluded. Thus, two treatments with phoxim locally in the ears showed a very high efficacy against *Otodectes cynotis* in farm foxes

participants all admitted that there was a lot to win by cooperation and formed for further actions four working committees: Breeding, Veterinary questions, Nutrition and Organizations. They also agreed about the most important tasks for the different groups as follows:

Breeding:	Coordination of breeding journals and grading systems.
Nutrition:	Nutritional value of feed ingredients and the effect of different levels of fat and protein in fur animal feed.
Veterinary:	Supression of distemper and prevention of chewing among young kits.
Organizations	Coordination of systems for live animal and pelt shows and agreement about exchange of breeding stock; furthermore coordination of auction dates and price politics.

Officially Subsection for Fur Animals was established in NJF's congress in Oslo the 30th of June 1947. Among the pioneers, who were elected to the first board and working committees ought to be mentioned at least the following persons:

Amanuensis Per Slagsvold, Norway chairman of the board; agronomist Alf Lund, Denmark secretary of the board and chairman of the Committee for breeding; agronomist Sam Nordfeldt, Sweden chairman of the Committee for nutrition; inspector R. Rochman, Norway chairman of the Committee for veterinary questions and of the Committee for organizations.

This sensible organization of Subsection for Fur Animals has remained almost unchanged through the entire 50 years. The Committee for organizations was, however, soon omitted and later on the Committee for ethology and behaviour has been added. The fifth Nordic country Iceland was included in the group in 1985 and after that all official organs have had at least five members, one from each country.

One of the reasons for the successful work of the Subsection for Fur Animals has been good connections to the breeders' organizations, who have even financially supported the activities. Very important have also been the personal contacts and friendships established in the course of activities. These personal ties of friendship between researchers have made it easy to share information and discuss research results and plans between colleagues from other Nordic countries.

The present organization

Members to the board and the permanent committees are elected every fourth year. Present members are:

Board of the Subsection:
Professor, Dr. Einar J. Einarsson, Norway (chairman); State veterinary Torbjörn Mejerland, Sweden; Prof. Dr. Maija Valtonen, Finland; Lector, Lic.Agro. Niels Enggaard Hansen, Denmark; Rector Magnus B. Jónsson, Iceland and Dr. Øystein Ahlstrøm, Norway (secretary).

Committee for breeding:
Agr. Kai-Rune Johannessen, Norway (chairman); Dr. Gabrielle Lagerkvist, Sweden; MMM Hilkka Kenttämies, Finland; Agr. Ulla Lund Nielsen, Denmark; Dr. Magnus B. Jónsson, Iceland.

Committee for nutrition:
Lector, Lic.Agro Niels Enggaard Hansen, Denmark (chairman); Prof. Dr. Anders Skrede, Norway; Agr. Eva Aldén, Sweden; M.Sci. Agr. Ilpo Pölönen, Finland; Agr. Bragi Lindal Olafsson, Iceland.

Committee for veterinary:
Chief vet. Per Henriksen, Denmark (chairman); Vet: Jan Fougner, Norway; Vet. Louise Treiberg-Berndtsson, Sweden; Vet. Erik Smeds, Finland; Vet. Eggert Gunnarsson, Iceland.

Committee for ethology:
Dr. Vivi Pedersen, Denmark (chairman); Dr. Morten Bakken, Norway; Prof. Dr. Mikko Harri, Finland; Vet. Louise Treiberg-Berndtsson, Sweden; Vet. Eggert Gunnarsson, Iceland.

The activities of fur animal section

Permanent committees
The four standing committees usually meet once or twice a year to discuss resent research results and future plans and cooperation within their own area. Within these groups have several joint Nordic research projects and publications been initiated.

Annual fur animal seminars
Already from the beginning it has been a tradition for the members to meet in an annual fur animal seminar. In 1950's these meetings gathered about 20 people but along with the expansion of fur production the number of participants has increased to 100-175 in the last years. These large seminars are the meeting forum for the scientists and the advisory section where the latest research results are presented. Also the leaders of feed kitchens and large farms have found them valuable.

Scientific work shops
As the participation in the annual seminars increased with people of varying background there was not place for deep scientific discussions in these meetings. Since 1981 has fur animal section therefore arranged separate scientific workshops where specialist can meet around a selected research area or problem. Until now altogether 13 scientific workshops have been arranged.

Nordic post graduate courses
Subsection for Fur Animals has also initiated post graduate courses on subjects important in fur animal production. These courses have been arranged in cooperation with NorFa, the Nordic organ for post graduate education. The following courses have been held:

1981	Fur animal nutrition
1991	Reproduction in carnivorous fur bearing animals
1996	Hair and skin research methods

International congresses
NJF's Subsection for Fur Animals was also the first one to take initiative for fur animal scientists of the whole world to meet. The First International Scientific Congress in Fur Animal Production was held in Helsinki in 1976. This first congress started a tradition of international congresses to be held each fourth year. The idea of international congresses was in Toronto 1988 enlarged to founding of an International Fur Animal Scientific Association, IFASA. Since then has IFASA been responsible for arranging the international congresses.

Publications
The working committees have initiated many publications for the use of fur producers and researchers. The first one of these was a general guide book of fur farming "Mink - avl og opdræd" edited by Alf Lund and published in 1961. A new edition was prepared in 1966, translated to all Nordic languages and financed by the fur breeders organizations. Since then eight books have been published on more specific subjects.

Literature service and Scientifur
Before the computer times it was quite a task for a researcher to keep track on the literature. Even on this field cooperation was found to be sensible and thus the subsection started a literature service in the middle of 1960's. Abstracts of fur animal articles were printed on special cards which could be sorted according to different key words. The system was run from a central place and distributed to all Nordic countries. In the first international congress in 1976 Gunnar Jørgensen from Denmark launched the genial idea of publishing these abstracts in a form of a magasin SCIENTIFUR. Since then has Scientifur efficiently distributed information about research concerning fur animals to all parts of the world.

Since the IVth International Congress in Toronto 1988 has IFASA been responsible for Scientifur.

Catalogue of research projects
In 1994 Subsection for Fur Animals decided to collect a list of fur animal research projects in the Nordic countries. The catalogue has since then been updated two times, the latest issue is from 1996 and a new updating is due early in 1998.

Future activities
During the 50 years of its existence Subsection for Fur Animals has achieved a strong position as a contact organ between scientists in the Nordic countries. At the same time, however, it has been open for a larger international cooperation. More and more often researchers from outside the Nordic countries find it relevant to meet the Nordic colleagues at the annual seminars. The use of English is therefore increasing between colleagues and even in the Nordic meetings. Even though NJF's Subsection for Fur Animals is primary a Nordic organization it will also have a central role as a forum for international activities within fur animal research.

Summarized and translated by Outi Lohi.

Nordiske Jordbrugsforskeres Forening

Subsektion for Pelsdyr

50 års jubilæum
1947-1997

Niels Glem-Hansen

NORDISKA
JORDBRUKSFORSKARES
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Fur Animal Division

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NJF UTREDNINGAR - RAPPORTER

Health and diseases in mink *(Mustela vison)*

Hans Henrik Dietz

Multifactorial diseases have gained increased importance within fur animal production during the last decade.

It has been necessary to revise the classical concept of disease in fur animal production as the diseases are often present as complicated cases with great variation between farms. Some of the important factors influencing the delicate balance between disease and health can be categorised in four groups viz. pathogenic agents, factors at the farm, management factors, and food quality and composition.

To ensure a continuously healthy production it is important to run a stable production at all levels and when changes are wanted or necessary to introduce these gradually and one at a time. The importance of further national and international cooperation among advisors and scientific institutions to ensure a constant up to date knowledge of disease factors is stressed.

NJF Seminar no. 280 / NJF Report no. 116, pp. 9-14, Helsingfors, Finland 6. - 8.10.1997. In DANH, Su. ENGL. 2 figs. Author's summary.

Diarrhoea in young mink kits in Sweden

Eva Aldén, Torbjörn Mejerland

Diarrhoeas in young mink kits (sticky kits) have occurred in Swedish mink farms for more than 30 years. Originally seen as a weaning sickness the disease occurs at younger and younger ages.

In about 200 mink farms slightly more than fourty are affected each year. Roughly 30 % of the production is involved. The diarrhoeas occur at all sizes of farms and both at farms preparing their own feed and at customers of central feed kitchens (70 % of affected farms in 1997).

A little more than half of the farms are found in farm areas and the rest are situated more isolated. North of a line from Stockholm-Karlstad diarrhoeas haven't been observed but have occurred in areas with a hard winter climate.

The feed includes raw slaughterhouse by-products and farms with diarrhoea include both those who prepare feed daily and 3-4 days a week until the end of May. When preparing feed daily the number of exposed farms has been lower.

The incidence of Aleutian disease probably has importance for the mortality but isn't decisive for the occurrence of the diarrhoeas. Later mating of especially older females sometimes gives several whelping peaks, a more lengthy whelping period and a higher number of late born kits. Sometimes there has been observed a greater number of sticky kits among the latest born.

Litters after young females haven't constantly had a higher degree of diarrhoea than others. In the extremely short haired black mink, sapphire and white mink the degree of diarrhoea has often been highest. Unevenness and variety in energy supply from January to whelping can be great and a more even energy supply gives rise to less problems and seems to establish a faster increase in appetite in the females at the start of the lactation period.

At a lengthier whelping period, for instance influenced by mating system, the best adaptation to feed composition and even supply is more complicated. With peroral antibiotic treatment of small kits and females plus treatment via the feed to older kits good treatment effects have often been reached.

Yet an established resistance towards different bacteria sometimes seems to disturb the effect of the treatments. Mortality varies considerably between farms for instance depending on time for start of treatment. Mortality has reached as much as a half kit per mated female.

With microscopic examinations of intestine villi, the same damage of intestinal epithelium has been observed which can be seen with rota virus infections.

More exact information regarding energy supply from January to whelping ought to be collected and estimated.

The immunological status of the milk of the females at parturition and the three following weeks ought to be studied.

Our present opinion is that the cause of the diarrhoeas is multifactorial.

NJF Seminar no. 280 / NJF Report no. 116, pp. 15-26, Helsingfors, Finland 6. - 8.10.1997. In SWED, Su. ENGL. 1 table, 1 fig., 21 refs. Authors' summary.

Histology of intestines of mink kits with diarrhoea

Bertil Järplid, Torbjörn Mejerland

The study was performed in so-called "sticky mink kits" with diarrhoea. Thirty-three kits at the age of 17 - 33 days from 15 different litters were sacrificed and fixed in formalin. From the posterior 40 cm of the small intestine samples were taken from 30 different places for histology. Lesions, mainly localised to the mucosal villi, were found in all the animals. Predominant findings were degeneration and desquamation of epithelial cells and atrophy and fusion of villi. Subepithelial edema in the villi, inflammatory cells in the propria and eosinophilic, intracytoplasmatic inclusions in epithelial cells were also seen. One animal showed multinucleated epithelial cell syncytia at the tips of the villi.
Possible causes of the lesions are discussed.

NJF Seminar no. 280 / NJF Report no. 116, pp. 27, Helsingfors, Finland 6. - 8.10.1997. In SWED, Su. ENGL. Authors' summary.

Mink enteritis vaccines of the 21st century

Åse Uttenthal

Traditionally mink virus vaccines are one of two types.

One was "live virus vaccine" using a strain of virus who had lost the ability to produce disease upon infection, but still the strain had retained the immunogenicity. The vaccine strain induces a subclinical infection priming the animal to resist the actual disease if the wild-type virus is introduced. The other possibility was "killed virus vaccines" where virus was produced in animals or cell cultures and subsequently killed using e.g. formalin. This left the viral protein in suspension devoid of live virus.

Now new technology has opened a door for a variety of new vaccine types all based on protein parts. These new vaccines are comparable to killed vaccines but they contain specifically the requested proteins and no left-over from cell-cultures, media or other unwanted parts along the line of production. Another great advantage is that they are not infectious.

My presentation will focus on two new production systems, which we have worked with:

1) Synthetically produced peptides (i.e. very small proteins).
2) Vaccines to mink produced in a bean plant; here also only small parts of mink virus proteins are expressed.

We have tested both types in mink. They look promising.

The review is based on these papers:
Langeveld, J.P.M., Kamstrup, S., Uttenthal, Å., Strandbygaard, B., Vela, C., Dalsgaard, K., Beekman, N.J.C.M., Meloen, R.H., Casal, J.I. (1995): Full protection in mink against mink enteritis virus with new generation canine

parvovirus vaccines based on synthetic peptide or recombinant protein. *Vaccine 13*: 1033-1037.

K. Dalsgaard, Uttenthal, Å, Jones T.D., Xu, F., Merryweather, A., Hamilton, W.D.O., Langeveld, J.P.M., Boshuizen, R.S., Kamstrup, S., Lomonossoff, G.P., Porta, C., Vela, C., Casal, J.I., Meloen, R.H., Rodgers, P.B. (1997) Plant-derived vaccine protects target animals against a viral disease. *Nature Biotechnology 15 March* :248-252.

NJF Seminar no. 280 / NJF Report no. 116, pp. 29, Helsingfors, Finland 6. - 8.10.1997. Author's summary.

Dual-energy x-ray absorptiometry scanning (Dexa) in mink (*Mustela vison*)

Asbjørn Brandt

The estimation of whole body fat (BF), lean body mass (LBM), bone mineral content (BMC) and bone mineral density (BMD) in mink has previously been performed using laborious total body determination either on carcasses or following systematic sacrifice.

I introduce and suggest the newly developed and sophisticated dual-energy X-ray absorptiometry scanning (DEXA) technique as a non-invasive and more ethically correct, efficient alternative method for measuring these parameters.

The monitoring of *in vivo* bone mineralization by the DEXA method is superior to the present day alternatives such as radioactive tracer methodology, clinical chemistry, total bone mineral-atom spectrophotometry, X-ray photodensitometry and photon absorptiometry.

I stress the DEXA precision and efficacy and the possibility of performing series of measurements particularly in experimental designs where the dynamics of whole body bone and multiple (bone) site mineralization *in vivo* is the scope.

I evaluated the applicability of the DEXA scanning technology in measuring and estimating the body fat, lean body mass and bone mass density in normal Danish, with farm feed fed mink kits of different ages and the two sexes.

The results of the study can be used as a basis for further studies in physiologic and pathologic situations that might affect bone mineralization in mink.

NJF Seminar no. 280 / NJF Report no. 116, pp. 41-42, Helsingfors, Finland 6. - 8.10.1997. In DANH, Su. ENGL. Author's summary.

Genetic diversity of Aleutian mink disease virus

A. Olofsson, L. Treiberg-Berndtsson, L. Lind, S. Belák, T. Mejerland

The Aleutian mink disease virus (AMDV) is a parvovirus, causing a slowly progressing immune complex disease in adult mink and can give acute pneumonia in mink kits. The virus is common in mink populations but is mostly pathogenic for mink of the Aleutian phenotype. It has been found in both high and low virulent forms. The genome is a single stranded DNA, composed of approximately 5000 nt. The coding regions consist mainly of two large open reading frames.

Although several types of AMDV are known and to some extent characterised mainly in Denmark, not much is known about the strains circulating in Swedish mink farms and other Scandinavian countries.

The aim of the present study was to develop a polymerase chain reaction (PCR) method for the identification of the isolates prevalent in Sweden, and compare the nucleotide sequences with those of previously known isolates from other countries.

Approximately 70 samples were collected from 10 farms in the Southern part of Sweden. Primers were constructed over an area with a

high degree of variation in the left open reading frame of the viral genome. In an attempt to amplify both high and low titer samples, semi-nested PCR was performed, generating PCR products of 390 bp in length. The PCR products were sequenced and compared with each other and with previously known strains. The preliminary data show a high genetic variability of AMDV in the Swedish mink farms, forming two main groups of virus similar to ADV-United and ADV-K, respectively. Based on the sequence differences we have attempted

NJF Seminar no. 280 / NJF Report no. 116, pp. 43-44, Helsingfors, Finland 6. - 8.10.1997. In SWED, Su. ENGL. Author's summary.

Residuals of melatonin implants in feed and their effects on reproduction of blue foxes (*Alopex lagopus*)

T. Dahlman, J. Mäkelä, H. Korhonen, P. Niemelä.

The aim of this study was to evaluate if melatonin residuals in the feed affect reproduction of blue foxes and early development of cubs. Two feeding groups, melatonin and control group, were assigned each from 50 female and 16 male foxes. The research started in January and continued to weaning. Animals were weighed, feed consumption was measured and breeding results were calculated. The basic feed composition of the melatonin group was the same as the control feed but it was supplemented with 10 % thermo-treated carcasses originating from melatonin implanted animals.

Melatonin capsules were implanted subcutaneously in mid-July. At that time, melatonin content of the capsules was 12.0 mg. At pelting, in the end of October, the capsules contained 6.2 mg melatonin. The amount of melatonin in the thermo-treated carcass mass was 66.0 ppg/mg dry matter (DM) and 5.1 pg/mg DM in four carcasses where melatonin capsules had been removed.

There were no statistical differences in weights of the breeding animals or in early growth of the cubs. Nor were there any statistical differences in whelping results or cub mortality. Feed consumption was normal in both groups.

Conclusively, according to the results of the present study melatonin residuals in the feed have no adverse effects on the performance of blue foxes during breeding and lactation season.

NJF Seminar no. 280 / NJF Report no. 116, pp. 47-52, Helsingfors, Finland 6. - 8.10.1997. In SWED, Su. ENGL. 5 tables, 12 refs. Authors' summary.

Effects of dietary protein levels on physiological parameters and health in mink (*Mustela vison*)

Birthe M. Damgaard, Tove N. Clausen

Effects of dietary protein levels of 15%, 20%, 25%, 30% and 35% of metabolizable energy (ME) were investigated in male mink kits during the growing period from July to pelting in December. Furthermore, the effects of a low protein diet (15% and 20% of ME from protein) supplemented with essential amino acids to meet the estimated requirements in growing mink were investigated. The dietary fat levels ranged in a reciprocal fashion from 67% to 47% of ME and the dietary carbohydrate level was 18% of ME in the diets. Hepatic fatty infiltration, weight of liver, mortality rate, plasma activities of alanine-aminotransferase (ALAT) and plasma concentrations of total protein and urea were studied.

Low dietary protein levels caused hepatic fatty infiltration, increased plasma activities of ALAT and increased mortality rate. The plasma concentrations of total protein and urea were influenced by the dietary protein level. A dietary supplement of essential amino acids to a low protein diet to meet the estimated requirements in growing mink did not improve health compared with the unsupplemented low protein diet.

Based on results from the investigations, it is concluded that the mink has a high requirement of dietary protein, and besides essential amino acids, especially glucogenic amino acids. The dietary protein supply to mink in the growing-furring period is proposed to be at least 30% of ME to ensure a low mortality rate.

NJF Seminar no. 280 / NJF Report no. 116, pp. 53-59, Helsingfors, Finland 6. - 8.10.1997. In DANH, Su. ENGL. 3 tables, 9 refs. Authors' summary.

Limitations to the use of marine lipids for mink

Christian Friis Børsting, Tove Nørgaard Clausen

During the latest years our research groups have performed two series of studies to evaluate performance and health in the growing-furring, reproduction and nursing periods of mink, which were fed:

i) increasing levels of fatty fish products of good oxidative quality
ii) varying oxidative quality of marine lipids used at a high proportion of the total dietary fat

From these series of experiments it was concluded, that diets containing 50 % of dietary fat from herring or mackerel scrap in the growing-furring period supported normal performance, skin characteristics and health of the mink. However, if approx. 70 % of dietary fat was from these products or from fresh fish oil some adverse effects occurred in regard to growth, skin characteristics and clinical indices. Inclusion of high amounts of moderately oxidised fish oil in the diet during this period impaired performance and health slightly more than inclusion of high amounts of fresh marine lipids.

The experiments performed in the reproduction and nursing periods with high levels of marine lipids gave somewhat contradictory results. Feeding herring scrap of good oxidative quality indicated that normal reproductive performance could be obtained even when approx. 70 % of dietary fat is from fish. On the other hand, in one of two experiments inclusion of such high levels of fish oil in the diet in the reproduction and nursing periods caused poor reproductive performance. Kit growth was very sensitive to high levels of fish oil in the diet during the nursing period inferring that 70 % of dietary lipid of marine origin is beyond the limit for inclusion of marine lipid in the diet during this period.

NJF Seminar no. 280 / NJF Report no. 116, pp. 61-69, Helsingfors, Finland 6. - 8.10.1997. 1 fig, 9 refs. Authors' summary.

Energy supply for blue fox and mink in the reproduction period

Øystein Ahlstrøm, Anders Skrede

The experiment was carried out to evaluate effects of different energy supplies for blue fox and mink females in the reproduction period (Jan-May) on reproduction, especially kit survival rate. The females were divided into three groups according to body weight, and the body weight differences among groups were maintained by different energy supplies.

In blue fox females, high initial body weights and high energy supply (2250 kJ per day) in the early phase of the reproduction period resulted in several cases of appetite loss and very low feed intake later in the reproduction period and during gestation. Females given the highest energy supply produced kits with low birth weight and poor viability. This may be due to low feed intake and suboptimal nutrient supply for the fetus during gestation. Females having more moderate body weights and with lower energy supply until mating, had the lowest body weight reduction during gestation. These females produce kits with higher body weights and better viability. Blood analyses of females taken after parturition revealed no differences among the three energy levels. The experiment

showed that blue fox females should be given restricted feeding in the period before mating to ensure the best survival rate of the kits.

In mink, the response of different energy supply was less pronounced than in the blue fox, but also for mink the highest body weights and highest energy supply (1500 kJ per day) resulted in the poorest reproduction. The results indicate that kit survival rate in mink is dependent on body weight of the female and the energy intake during the reproduction period. Moderate body weight at mating appears to increase the appetite of the females during gestation and improve nutrient supply for the fetus. The treatments did not effect plasma parameters in females shortly after parturition.

NJF Seminar no. 280 / NJF Report no. 116, pp. 71-78, Helsingfors, Finland 6. - 8.10.1997. In NORG, Su. ENGL. 7 tables, 5 refs. Authors' summary.

Development of an *in vitro* analysis for prediction of the protein digestibility of feedstuffs for mink

Christian Friis Børsting

At present no *in vitro* analyses are available for prediction of the protein digestibility of feedstuffs for mink and such values can only be obtained from *in vivo* digestibility trials with mink. The *in vivo* experiments are expensive and time consuming compared to *in vitro* analyses. Therefore, the aim of the present study was to develop an *in vitro* analysis for prediction of the protein digestibility in feedstuffs for mink.

In the development of the *in vitro* procedure 30 feedstuff samples of animal origin and 12 feedstuff samples of plant origin were engaged. For each of these 42 batches both a digestibility trial and an *in vitro* analysis were performed. The *in vitro* digestibility of protein, the so-called enzyme digestibility of N (EFN) was compared to the true digestibility of protein (SFN). SFN was calculated by correcting the apparent digestibility of protein for an endogenous protein loss of 16.4 g per kg of dry matter intake. EFN was determined after incubation of approx. 1 gram of sample at 40°C with pepsin at pH 3.0 for 6 hours followed by incubation with pancreatin at pH 6.8 for 16 hours. Solubilized, but not digested proteins were precipitated by sulphosalicylic acid after the incubation. Next, samples were filtered through glass filter crucibles. After consecutive washings with sulphosalicylic acid and acetone N was determined in the undigested residue.

Animal feedstuffs

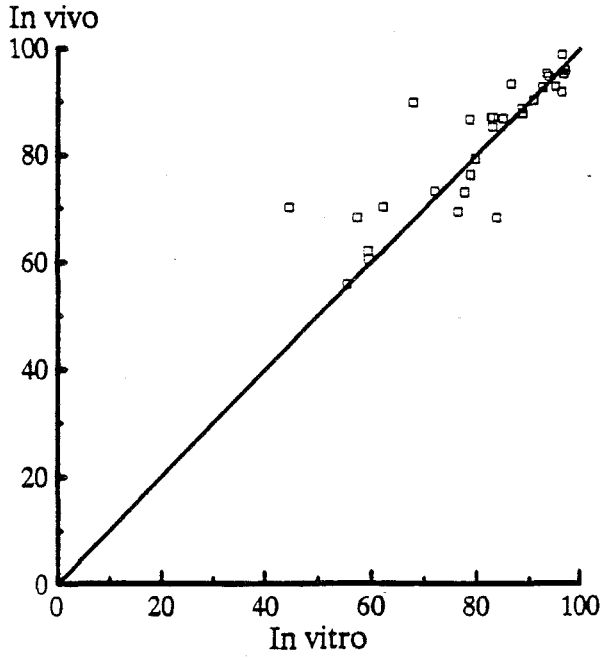

Fig. 1. In vitro digestibility of protein (EFN) compared to in vivo digestibility of protein (SFN) in mink

For the feedstuffs of animal origin EFN and SFN were of comparable size, whereas in general SFN was lower than EFN for feedstuffs of plant origin. Therefore, it was necessary to develop separate regression equations for the two sets of feedstuffs. Within the feedstuffs of animal origin there was a high correlation (r=0.92) between EFN and SFN, when 2 outliers (fishmeal) were excluded. The correlation was also high (r=0.94) for the plant feedstuffs except for corn gluten meal. One reason for the lower SFN values com-

pared to EFN values for the plant feedstuffs could possibly be that the proteolytic enzymes of the mink are more sensible to inhibitors in plant products compared to the pig enzymes used in the EFN analysis. Another reason might be that plant products cause higher losses of endogenous protein than corrected for when calculating true protein digestibility.

In conclusion, it will be possible to further develop the EFN-procedure to be a useful tool for screening new and altered feedstuffs for their protein digestibility in mink. In addition the method can be used as a routine analysis of protein digestibility in batches of feedstuffs used at commercial feed kitchens producing mink feed.

NJF Seminar no. 280 / NJF Report no. 116, pp. 79-88, Helsingfors, Finland 6. - 8.10.1997. In DANH, Su. ENGL. 2 tables, 2 figs., 9 refs. Author's summary.

Wheat gluten - an alternative protein source in mink nutrition

Aloys Laue, Carsten Hejlesen, Christian F. Børsting

Wheat gluten supplies a chemical composition similar to other protein sources already used in mink feed. Therefore an experiment was initiated with the objective 1) to estimate digestibility coefficients for protein and amino acids in wheat gluten and 2) to evaluate the palatability of wheat gluten.

Digestibility experiment: The experiment was conducted with 6 groups of 3 male mink (colour type standard) per group. The trial consisted of a 10-day adjustment period followed by a 4-day collection period. Experimental diets were prepared by adding graded levels (0, 6, 12, 18, 24 and 30%) of wheat gluten to the basal diet balanced to contain 35%:45%:20% (crude protein:crude fat:crude carbohydrates) on metabolizable energy basis. Dry matter, protein, amino acids and fat were analysed in feed and feces samples to determine digestibility coefficients.

Palatability experiment: The experiment was conducted as a preference test with 2 groups of 9 male mink (colour type standard) per group. Simultaneously, each animal had unrestricted access to both the control diet without wheat gluten and the test diet with 5% wheat gluten. The duration of the trial was 3 weeks.

Experimental results of the digestibility coefficients of crude protein, crude fat, crude carbohydrates and the 4 amino acids cystine, lysine, methionine and threonine were 0.95, 0.94, 0.38, and 0.91, 0.91, 0.96 and 0.86, respectively. Furthermore the palatability experiment showed no differences in feed intake between the control and wheat gluten diet during the first two weeks, while there was a significant increase in feed consumption of the wheat gluten diet compared to the control diet in the third week ($P<0.05$).

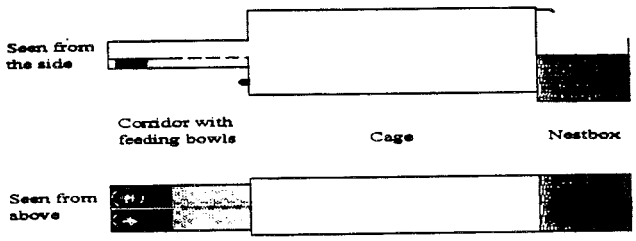

Fig. 1. Sketch of the palatability mink cage

In conclusion a) the high digestibility of protein as well as cystine, lysine, methionine and threonine makes wheat gluten an attractive protein source in the formulation of mink diets; b) addition of wheat gluten to mink feed improves the palatability of the diet; c) use of large quantities of wheat gluten in the production of mink diets does not meet the requirements for methionine and must be considered in the diet formulation and d) wheat gluten influences the physical properties of the diet, such as increasing water binding capacity and improving feed consistency.

NJF Seminar no. 280 / NJF Report no. 116, pp. 89-95, Helsingfors, Finland 6. - 8.10.1997. 5 tables, 1 fig, 3 refs. Authors' summary.

Hippuric acid excretion in mink fed increasing levels of benzoic acid

I. Pölönen, V. Toivonen

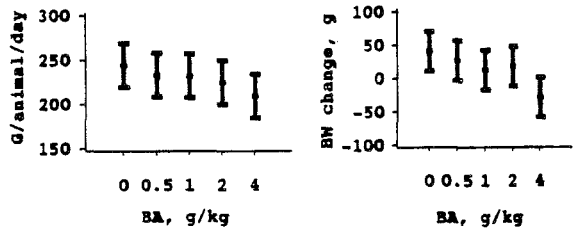

Fig. 1. Average feed consumption and change of BW of the adult male mink fed increasing concentrations of benzoic acid (BA) in the feed for five days

The efficiency of mink to conjugate benzoic acid and glycine to form benzoylglycine, i.e. hippuric acid, was studied. 30 adult, male mink were randomly divided into five feeding groups, and fed for five days in cages equipped with total collection of feces and urine. The basal feed, 250 g/animal/day, contained Baltic herring, slaughter offal, cod fillet offal, cooked barley, fish meal, vegetable oil and vitamin premix. Benzoic acid was added 0, 0,5, 1,0, 2,0 or 4,0 g/kg feed.

Feed intake and body weights were non-significantly affected by the feed's increasing benzoic acid. None of the mink showed symptoms of toxicity. A diurnal hippuric acid excretion varied from 0,02 mmol/kg BW (SE ±0,001) of the mink on basal feed to 1,8 mmol/kg BW (SE ±0,34) of the mink receiving 4,0 g/kg benzoic acid in their feed. With the inclusions, 0,5 and 1,0 g/kg, equalling up to 1 mmol/kg BW, recovery of benzoic acid as hippuric acid was over 80% on average but decreased curvlinearly to 50% with the highest inclusion, equalling 3 mmol/kg BW. This preliminary short trial showed that mink conjugate benzoic acid and glycine into hippuric acid efficiently even when intake of benzoic acid is 1 mmol/kg BW i.e. approximately 1g/kg ready mixed feed. It is very likely that the elimination of benzoic acid in mink resembles most other mammals, especially carnivores - including ferret - that are able to conjugate benzoic acid with glucuronic acid, too. It is known that the domestic cat has a defective glucuronic acid pathway and overdose of benzoic acid leads to a toxicosis. According to this short-term study it can be recommended that mink feed may contain 1 g /kg benzoic acid.

NJF Seminar no. 280 / NJF Report no. 116, pp. 97-101, Helsingfors, Finland 6. - 8.10.1997. 2 figs., 9 refs. Author's summary.

Comparative nutrient digestibility in blue fox, mink, dog and rat.

Øystein Ahlstrøm, Anders Skrede

Digestibility experiments with six dry dog feeds were carried out in order to study differences among species in digestive capacity and to examine correlations in digestibility among blue fox, mink, dog and rat for assessing whether digestibility values in one species could be used as models for the others. Significant differences in digestibility of main nutrients among diets and among species were observed. Generally digestibilities decreased with increasing dietary carbohydrate content.

Blue fox and dog had highest digestive capacity for protein and fat, and there were no differences between these two species in digestibility of main nutrients. Mink showed generally the lowest digestive capacity, especially for diets with high carbohydrate content. Blue fox digestibility can be used directly as a model for dog digestibility and vice versa for protein, fat and carbohydrates, while mink digestibilities had even higher correlations to dog digestibility. Mink digestibility may therefore be used to estimate blue fox and dog digestibility by means of regression equations.

Rat digestibility deviated from digestibilities in the other species for some of the main nutrients, especially carbohydrates. These deviations were probably owing to the higher rate of fermen-

tation in the hindgut of the rat compared with that in the carnivores.

NJF Seminar no. 280 / NJF Report no. 116, pp. 103-108, Helsingfors, Finland 6. - 8.10.1997. In NORG, Su. ENGL. 5 tables, 9 refs. Authors' summary.

Measurement of daily milk intake in suckling fox cubs

Øystein Ahlstrøm, Søren Wamberg

A preliminary study of the daily milk intake in fox cubs by means of the tritiated water dilution technique showed that blue fox cubs increased their milk intake from 13-15 days of age to 19-21 days of age. There was a substantial variation in milk intake among cubs within each litter. This variation may be due to natural variation, but also the fact that water intake from other sources than milk, most likely moist feed, may have occurred in some of the cubs. Such additional water intake will interfere in the calculations and result in overestimated values of milk intake. For blue fox cubs the milk intake increased from 30-40 ml per cub per day at 13-15 days of age to 60-70 ml per day at 19-21 days of age. For silver fox cubs the milk intake was estimated to be about 100 ml per cub per day at 17-21 days of age. The results of the study show that fox females produce about 500-700 ml milk per day depending on the litter size and the age of the cubs.

NJF Seminar no. 280 / NJF Report no. 116, pp. 109-112, Helsingfors, Finland 6. - 8.10.1997. In NORG, Su. ENGL. 1 table, 6 refs. Authors' summary.

Does the "solitary" mink benefit from having company?

S.W. Hansen, B. Houbak, J. Malmkvist

Behaviour and production properties were compared between groups of mink weaned individually, in pairs or kept in family groups. Weaning of mink kits individually at the age of 6 weeks had considerable negative consequences on their behaviour. If the kits are weaned individually, they will issue calling sounds for at least 15 hours after weaning. In the growth period, the frequency of ego-play, stereotypies and marking behaviour is increased in comparison with mink in pairs or in family groups. As an important consequence of the early individual weaning, the kits react more fearfully towards humans, conspecific intruder and novel object than kits weaned in pairs at the age of 7 weeks. Fully grown, the mating capability of the males is reduced considerably in comparison with males weaned at the age of 7 weeks and males raised in family groups.

It was not possible to prove increased welfare of mink kept in family groups in comparison with mink weaned in pairs at the age of 7 weeks. The frequency of marking behaviour and stereotypies, social play and neck pulling was identical in the two groups, whereas the frequency of aggression, social and self grooming, and ego-play was higher in mink kept in family groups than in mink kept in pairs. Social play is, however, the most frequently occurring behaviour during the growth period and most frequent at the end of July, when the frequency of this behaviour decreases.

In September, the frequency of aggression, marking behaviour and stereotypies increased. The increase in these behavioural elements may be related to the minks' natural territorial way of life or to the establishment of a social dominance hierarchy under enforced social contact.

NJF Seminar no. 280 / NJF Report no. 116, pp. 115-122, Helsingfors, Finland 6. - 8.10.1997. 23 refs. Authors' summary.

Behaviour and reproduction in groups of farmed foxes (*vulpes vulpes*)

Vivi Pedersen

The project "Altruism in the red fox in Denmark" began in 1997 on wild foxes. In short, the

aim of the project is to examine the existence of altruists (helpers) in red fox populations and their social role and part in maternal care. An experimental sub-project on farmed foxes was commenced at the same time with the aim to get more information about social and infanticidal behaviour in foxes.

In the experimental sub-project, eleven groups were formed prior to the mating season. Each group consisted of two vixens and one male, all unrelated. The group was housed in an enclosure measuring 12x2.4x2m. The vixens in a group differed in their pelt colour to ease later identification. The male was either of the silver type or the red colour type.

Various behavioural observations and tests were performed during the mating season and breeding season in order to evaluate the dominance relationships between the adult foxes. Interactions between adult foxes and between adult foxes and cubs were monitored as well. Regarding reproduction, nine of the eleven groups had cubs. In three of these groups both vixens gave birth to a litter, but only in two did both litters survive. In single litter groups (6), only two groups had cubs, which survived until weaning (16 weeks of age). At weaning, the mother and one of her female cubs stayed together in 2/3 of the enclosure, whereas the male was kept alone in 1/3 of the enclosure. The rest of the cubs and those vixens, which did not succeed in weaning female cubs, were removed from the experiment.

In the contribution, the hypothesis about altruism and infanticidal behaviour will be presented, as well as preliminary results from the wild fox and farm fox projects. The results will be discussed in the light of present theories and knowledge about social behaviour and infanticide.

NJF Seminar no. 280 / NJF Report no. 116, pp. 123-124, Helsingfors, Finland 6. - 8.10.1997. In DANH, Su. ENGL. Author's summary.

Behaviour of silver foxes (*Vulpes vulpes*) in ground floor enclosures

T. Pyykönen, L. Ahola, L. Jalkanen, M. Harri

Observing animals in a semi-natural environment provides good basis for studying animal behaviour. When developing new housing systems this information can be applied so that animals' needs are considered. The present study describes behaviour of young farmed silver foxes during winter in two ground floor enclosures measuring 15 x 15 m. Some details of their reproduction are also discussed.

Two sisters and a male fox were housed in pen 1 and a silver fox couple in pen 2. Each pen was furnished with several nest boxes with two entrance tunnels, a wire mesh cage, a rain shelter and a resting platform. Winter period (February and March) included observations of activity, digging, use of space and social contacts. At whelping time the observations concentrated mainly at reproduction, the number of whelped cubs and their nursing. The nest boxes were checked three times a day and special attention was given to the group of two vixens in pen 1 in order to find out whether social hierarchy has an effect on reproduction.

In winter foxes the males rested 73.5 % of the time, while the vixens rested only 64.8 %. The males were more passive in general. The most popular places for resting were the ground, the roof of the rain shelter and the nest box. The nest boxes were mostly used during the working hours. The males used them more than the females. Foxes preferred the roof of the rain shelter as a sleeping and observation place. The foxes were active 21.5 % of observed time. The rest of the time was spent sitting or observing the environment while in a lying position. When active, foxes used widely all the available space and furniture. Digging occurred mostly in dark periods and in short-lasting intervals. In total foxes used only 0.2 % of their time for digging. The reasons for digging seemed to be linked

with exploring, food caching and marking. The most usual forms of social contacts were play, aggressive behaviour and exploration of each other occurring mostly after working hours.

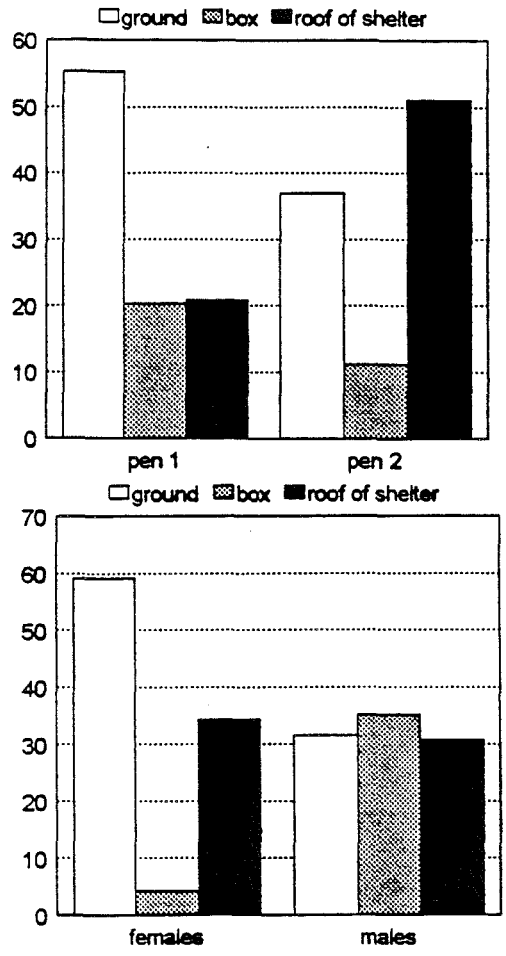

Fig. 1. The three most popular places for male and female foxes in different enclosures

All the vixens reproduced. In pen 1 the subordinate female whelped earlier and got fewer cubs than the dominant female. The subordinate female took some cubs from her sister soon after birth. After those cubs were mixed very often, but later both vixens took care of the cubs by turns and all the cubs lived in the same nest. The male was not seen to take part in cub care but he protected the cubs and played with them.

NJF Seminar no. 280 / NJF Report no. 116, pp. 125-131, Helsingfors, Finland 6. - 8.10.1997. 1 table, 2 figs., 5 refs. Authors' summary.

Effects of a top nest box on production and behaviour in blue foxes

Mikko Harri, Jaakko Mononen, Teppo Rekila, Hannu Korhonen

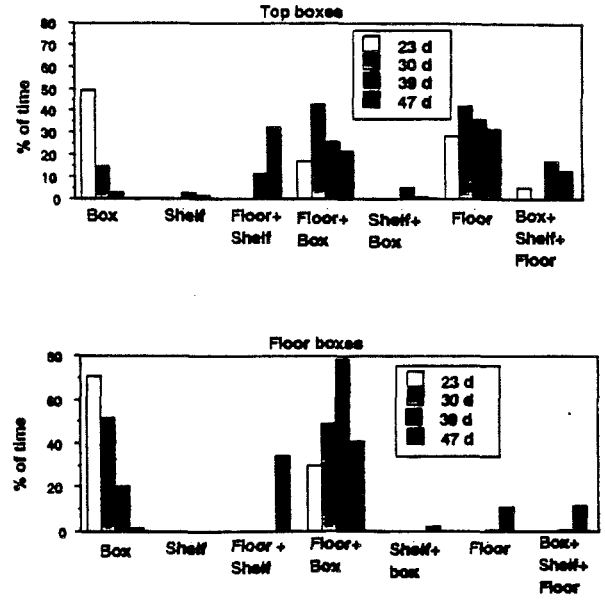

Fig. 2. Distribution of pups in cages with top boxes or floor boxes from 23 to 47 d postpartum. Box = the whole litter inside, Floor + shelf = some cubs are on floor and some on shelf, etc.

The effect of a top nest box on production-related parameters and behaviour was examined in a field trial. In the breeding season 50 vixens had top boxes and 50 control vixens had floor boxes. After weaning two groups of 24 growing blue fox cubs had cages with top boxes and wire mesh platforms whereas control animals had platforms only. Primiparous vixens had smaller litters (NS) and higher cub mortality during the first week postpartum ($p<0.001$) than multiparous vixens. However, there were no significant differences between top box and floor box groups. Cubs appeared from the boxes when they were about 4 weeks old and significantly earlier from top boxes than from floor boxes ($p<0.05$). Thereafter the proportion of cubs staying inside the boxes quickly decreased. The same phenomenon was observed for the vixens. Typically, at any particular moment, cubs were seen in all possible places of the cages. There were no differences in weight gain between groups. Dirtiness of nest boxes decreased towards the

end of the season. By October over 90 % of the boxes were scored as acceptable. Fur quality tended to be lower in nest box groups, due to staining from faeces and urine. The use of the nest boxes seemed to depend more on the individual animal rather than its species. Three individuals accounted for almost one half (48 %) of the total use while the 12 least enthusiastic users accounted for less than 5 % of the total use by 20 as assessed by video-recording. The enthusiastic users were in the box mainly in the night. In the feeding test and disturbance test, more individuals from the nest box groups showed fear-related reactions. A transparent front wall did not reduce the number of timid individuals. Fearfulness resulting from nest box history is a negative feature both from a practical and from an animal welfare point of view.

NJF Seminar no. 280 / NJF Report no. 116, pp. 133-144, Helsingfors, Finland 6. - 8.10.1997. 5 tables, 3 figs., 15 refs. Authors' summary.

Operant conditioning in welfare research of silver foxes (*Vulpes vulpes*): a pilot study

Jaakko Mononen, Mikko Harri

Operant conditioning techniques have been used in animal welfare studies in several farm animal species to create demand functions. With the aid of the demand functions we can compare the relative importance of various commodities to the animals. In assessing the demand functions, the animals are trained to work for a commodity. The workload needed to obtain a constant amount of a commodity (or reward) varies between the experimental sessions. The logarithm of the amount of the obtained reward is plotted against the logarithm of the workload.

The slope of this descending curve indicates the importance of the commodity: the flatter the curve the more important the commodity is to an animal. Typically, the demand for feed is inelastic, i.e. animals are ready to work hard to get it. The demands for other commodities can then be titrated against the demand for feed. The less elastic the demand for a commodity, the more important that commodity is to animal's welfare.

We assessed the demand for dry feed in four adult female silver foxes. The foxes were trained to pull a plastic-covered wire loop connected to a switch-counter system to get feed. The actual experiment consisted of 20 two-hour sessions for each animal. In the first session the fixed ratio (FR) was 1, i.e. a fox had to pull the wire loop once to get 2 g feed. In the next three sessions the fox had to pull the loop for 4, 8 or 16 times, respectively, to obtain 2 g feed. This series of four sessions (with FRs 1, 4, 8 and 16) was repeated five times for each animal. The results presented here are based on the data from the last two series.

The amount of feed eaten during the sessions varied from 118 to 336 g. All foxes pulled the wire more than thousand times during the FR16 sessions. The slope for the demand curve for feed was 0.20±0.06 (absolute value, mean±SD). As expected, the foxes were willing to work hard for their food.

The rate of the responses of the foxes during the last 30 min period in the FR16 sessions was higher than in session with lower FRs, indicating that a two-hour session may have been too short for the foxes to gain as much feed as they wanted. This problem may be overcome either by lengthening the duration of the sessions or by lessening the force against which the foxes work.
The present results show that creating demand functions with the aid of operand conditioning is rather easy, although laborious, in farmed silver foxes. In future, we are going to assess the elasticity of the needs of silver foxes for commodities other than feed for example ground floor or objects for gnawing.

NJF Seminar no. 280 / NJF Report no. 116, pp. 145-151, Helsingfors, Finland 6. - 8.10.1997. 2 figs., 8 refs. Authors' summary.

Seasonal rhythm in serum cortisol in blue foxes

T. Rekilä, L. Jalkanen, T. Pyykönen, M. Harri

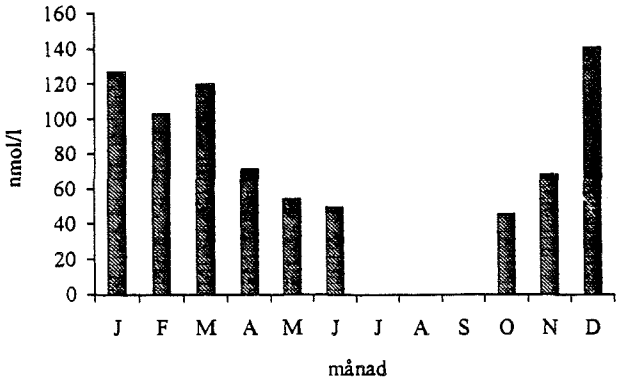

Fig. 2. Seasonal variation in the basic cortisol level of the blue fox

Seasonal rhythm in serum cortisol was studied in blue foxes. Blood samples were collected from 10 female and 10 male foxes twice a month from October 1996, except females during the whelping time. Half of the foxes were cubs; born in the spring of the year the experiment was started. The other half of the foxes were adults.

Average serum cortisol values for each month from October to June were; 45.9±18.4, 68.3±33.8, 140.9±53.6, 126.9±68.5, 102.8±32.7, 119.9±43.7, 71.3±35.3, 54.5±27.0 and 49.9±27.2 nmol/l, respectively. Serum cortisol in blue foxes varied significantly according to the time of the year ($P<0.001$, MANOVA). The highest levels were observed during the winter and the lowest during the summer. Neither age nor sex of blue foxes affected the level of serum cortisol ($P>0.05$, MANOVA).

NJF Seminar no. 280 / NJF Report no. 116, pp. 153-156, Helsingfors, Finland 6. - 8.10.1997. In SWED, Su. ENGL. 2 figs., 6 refs. Authors' summary.

Differences in adrenal and brain weights between blue foxes (*Alopex lagopus*) and silver foxes (*Vulpes vulpes*)

Liisa Nurminen, Juhani Sepponen, Jaakko Mononen, Mikko Harri, Teppo Rekilä

There are two farmed fox species: blue foxes (Alopex lagopus) and silver foxes (Vulpes vulpes). Welfare of farmed foxes is usually discussed without distinguishing between the two species. Although these species are closely related, there are several differences in their general behaviour. Blue foxes are, for example, less reactive than silver foxes. We have started a series of experiments in which we try to reveal the similarities and differences between the two fox species in their stress physiology and behavioural responses in various behavioural tests. As a part of these studies, we measured adrenal and brain weights of full-grown foxes.

Adrenal weight (both adrenals together) was 602±81 mg (n=42) in male and 498±79 mg (n=17) in female silver foxes ($p<0.001$). There was no difference ($p>0.05$) in the adrenal weight between male (313±55 mg, n=54) and female (319±54 mg, n=29) blue foxes. Brain weight was 48.0±2.1 g in male and 45.9±3.3 g in female silver foxes ($p<0.01$). Also in blue foxes, males had heavier brains than females: 38.2±2.7 g and 34.6±2.9 g, respectively ($p<0.001$). The differences between the sexes within each species vanished when body weight and some length measurements of the body were used as covariates. Thus, the sex differences reflect general sexual dimorphism in size. The differences between the species were highly significant ($p<0.001$) independently of whether body size measures were used as covariates or not. Thus, despite the heavier body weight ($p<0.001$), blue foxes have markedly smaller adrenals and brains than silver foxes.

NJF Seminar no. 280 / NJF Report no. 116, pp. 157-163, Helsingfors, Finland 6. - 8.10.1997.1 table, 30 refs. Authors' summary.

Behaviour and welfare of farm foxes in large earthen enclosures

Hannu Korhonen, Sakari Alasuutari, Auli Mäkinen, Paavo Niemelä

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. Recently, demands for more environmental and social enrichment in the housing conditions employed in the husbandry of fur farm animals have been put forward.

The present paper provides results of a 6-year behavioural study on adult and juvenile blue foxes (Alopex lagopus) (altogether N=25 males, N=29 females) housed in different-sized groups (4 to 11 individuals in each) employing seminatural earthen enclosures (17 m long x 8 m wide x 2 m high, or, 11 m long x 8 m wide x 2 m high).

The experiments lasted from 4 to 12 months each. Animal behaviour was visually observed in different periods of the year with each monitoring period lasting either 12 h or 24 h. Furthermore, weekly observations were made at feeding times (at intervals of 15-45 min each).

During the breeding season, behaviour was recorded by instantaneous sampling method using video camera equipment. The results showed that foxes formed a social hierarchy in which adults typically dominated over juveniles and males over females. Dominant individuals were often among the heaviest. Social tension and aggressions increased dramatically at the onset of the breeding season. Reproductive performance varied, depending on group composition, but often was poor. Foxes were observed to dig long subterranean tunnels, which were also in some cases used for denning.

According to the feeding test results, the number of fearless individuals increased with time. It can be concluded that foxes can be raised in groups during the summer and autumn without distinct difficulties. Thereafter, however, pronounced social conflicts among groups easily cause difficulties harmful to animal welfare.

NJF Seminar no. 280 / NJF Report no. 116, pp. 165-171, Helsingfors, Finland 6. - 8.10.1997. 4 tables, 12 refs. Authors' summary.

The importance of weight development and pelting time to the skin length of mink - An example of the development of production management by means of farm experiments

Steen Henrik Møller

The mink farmer improves his production management through gradual changes from year to year. Changing conditions cause variation in production results between years, which makes it difficult to evaluate the effect of a changed routine by comparing the production results. Other methods are therefore needed to evaluate the effect of potential management routines. In this investigation the possibilities of improving the production management through farm experiments were combined with the possibilities of the "Experience exchange groups" to examine relevant combinations of experiment conditions and to generalise the results by carrying out the same experiments under different production conditions. Specifically, the correlation between the body weight of the mink and the subsequent skin length was compared between farms which gave rise to include pelting time in relation to pelt maturity as an experimental factor the following year. The investigations showed that the regression of skin length on body weight varies between farms and colour types. It was somewhat surprising that the weight about one month prior to pelting was of greatest importance to the final skin length while weight changes during the last month before pelting did not have the same effect. In relation to a given final weight a positive effect on skin length was found if the mink had been even bigger and thus had lost weight before pelting. The relation between weight and skin length did

depend on the actual pelting time but for mink in the average weight interval the time of pelting was of little importance to the skin length obtained. It is concluded that farm experiments are well suited for evaluating the effect of potential management routines. By conducting the same experiment simultaneously on a number of farms (i.e. in an "Experience exchange group") it is possible to evaluate the generality of the results. The use of farm experiments within "Experience exchange groups" is therefore likely to become a useful instrument in the mink farmers' improvement of production management. Farm experiments may also produce valuable knowledge of interest to the mink industry in general.

NJF Seminar no. 280 / NJF Report no. 116, pp. 175-185, Helsingfors, Finland 6. - 8.10.1997. In DANH, Su. ENGL. 2 tables, 6 figs., 8 refs. Author's summary.

Colour measurement applied to understand visual judgement of colour shades in scanbrown mink pelts

Palle Vistisen Rasmussen

Microspectrophotometric methods were used to provide objective correlates for the visually evaluated colour shade of the underfur in scanbrown mink pelts.

The study included 21 scanbrown mink pelts (winter coat), representing a larger group of 87 mink pelts. The colour shade (RH), scaled from 1 (blue-greyish) to 5 (reddish), was graded visually across the general visual impression of lightness of the fur. Prepared hair samples of underfur were subsequently examined at three levels above the leather surface. Reflection curves were obtained from bundles of underfur fibres, and the hue (dominant wavelength) of the underfur was determined. Based on the CIE Lab colour space, values of L* (lightness, %), and the chromaticity co-ordinates a* (red colour direction), and b* (yellow colour direction) were calculated.

The visual blue-greyish colour shade was negatively correlated to the visual lightness of the fur in both groups ($r = -0.68$; $P = 0.0001$; $N = 87$ and $r = -0.75$; $P = 0.0001$; $N = 21$, respectively). The means of the hues were 589.40 nm, 588.00 nm and 586.70 nm, respectively, indicating that the variation between levels was small. The predicted value of the colour shade (RH_b) was estimated by the following polynomial regression: $RH_b = -33.16 + 1.56L^* - 0.018L^{*2} + 0.12a^* + 0.56b^*$, ($r^2 = 0.58$; $P = 0.005$). The partial regression coefficient of a* was not significant. Supplementary, macrophotometric, non-destructive methods could distinguish between groups of intact mink pelts judged to differ in regard to colour shade. However, the measuring values were influenced by the relatively dark coloured lanceolate part of the guard hairs.

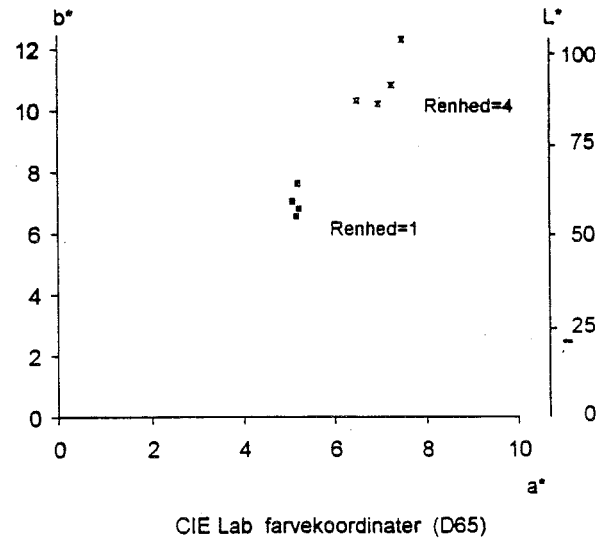

Fig. 3. L*a*b* measurements applied macroscopically on the ventral side of intact mink pelts. The two groups of pelts, evaluated visually to have purity values of 1 (blue-greyish) and 4 (reddish), are clearly separated in the diagram.

The model for the scanbrown type demonstrated that the visually graded colour shade was correlated to the lightness (L*) and to the yellow colour direction (b*), and contributed

fundamentally to the colourmetrical understanding of visual colour shade. The model may eventually standardise and thus improve the subjective grading of this property. Further, the use of photometric methods and the model may be used to establish discriminating threshold values in grading and selection of pelts and probably also of animals.

NJF Seminar no. 280 / NJF Report no. 116, pp. 187-195, Helsingfors, Finland 6. - 8.10.1997. In DANH, Su. ENGL. 3 figs., 11 refs. Author's summary.

The characterisation of soluble collagen extracted from dried mink skin using gel and capillary zone electrophoresis

Bent Riis

Mink skin physical properties are determined by proteins and other organic molecules. Many different protein components, including collagens, elastins and proteoglycans, are responsible for these characteristics. The major protein class in mink skins is the collagens. These proteins make fibrils and confer structural strength on the tissue. Dried mink skin contains several types of collagen subunits and precursors. This investigation has extracted collagen and procollagen from dried mink skins using two different methods. One method is known as "neutral salt extraction", and the other is known as the "acidic extraction method". The extracted collagens were characterised using SDS-PAGE techniques and capillary zone electrophoresis methods. The relative molecular weight of the collagen and procollagen units is determined. It is shown that the two methods extracted different fractions of collagens. Collagenase A enzymatic digestion shows that both extraction procedures extracted collagens. The capillary zone electrophoresis analysis identifies a number of peaks corresponding to the pattern found on the SDS-PAGE.

NJF Seminar no. 280 / NJF Report no. 116, pp. 197-203, Helsingfors, Finland 6. - 8.10.1997. 3 figs., 7 refs. Author's summary.

Keratins extracted from mink and fox hairs characterised by capillary and gel electrophoresis

Bent Riis

Mink hair properties are determined by the structural proteins found in the hairs, and the "hard" keratins are the major structural proteins found here. The most abundant keratin found in other mammalian hair is a-keratin, which is composed of several subunits.

Currently, not many details are known about the keratins found in mink or fox hairs although perfect hairs are the most valued single quality trait in fur animal pelts. This work was performed in order to try to disclose if mink and fox hairs are composed in a manner similar to more well characterised mammalian hairs (i.e. from humans and sheep).

This experimental series extracted keratins from mink and blue fox hairs using the same conditions. Capillary zone electrophoresis was performed on the extracted keratins to see if different amounts of tyrosine containing proteins were present in the different species. The extracted keratins were separated using various techniques.

NJF Seminar no. 280 / NJF Report no. 116, pp. 205-210, Helsingfors, Finland 6. - 8.10.1997. 1 table, 3 figs., 9 refs. Author's summary.

Why do farm mink chew fur?

Jens Malmkvist, Steffen W. Hansen

Mink males from breeding lines selected for (n = 12) and against (n = 12) fur chewing, and males from an unselected production line (n = 12) were used in this study, with the aim to gain more knowledge about the act of fur chewing and possible inducing factors. On the basis of 24-hour video recordings of 12 fur chewers, a circadian rhythm in the behaviour was found, with most occurrences around sunset and sunrise, and with no significant connection

between fur chewing and other forms of oral manipulations. Neither males selected for fur chewing nor males that phenotypically show most fur chewing displayed signs of increased sensitivity towards straw material, measured as changes in the cell population in the blood as a consequence of 7-day periods with/without straw. Likewise, no difference in blood counts of leukocytes and eosinophils between the groups of selected animals was seen after daily handling for 6 days; hence we have no evidence that fur chewers are more sensitive towards the used stressors. On basis of the data and the existing literature we conclude that understimulation/boredom may play a role in the execution of fur chewing in farm mink.

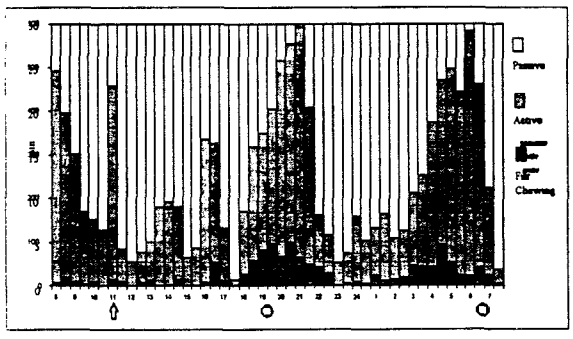

Figure 1. Time used on fur chewing of own pelt in relation to general activity during the day and night divided into 30 minutes intervals. Average of 12 males belonging to breeding line selected for much fur chewing. Arrow indicate feeding time, and suns marks time of sunset/sunrise.

NJF Seminar no. 280 / NJF Report no. 116, pp. 211-216, Helsingfors, Finland 6. - 8.10.1997. 1 fig., 16 refs. Authors' summary.

Temperament of foxes at private farms: heritability and association with reproduction traits

Sanna Nikula, Hilkka Kenttämies

The present study is part of the Finnish project included in the Nordic project "Selection for more confident farm foxes". The aim of the project is to study the genetic variation of the temperament and the association between behaviour and production traits in farm foxes.

29 private farms took part in the experiment during years 1995 and 1996 with a total of 21670 feeding test records. Temperament was defined using a feeding test with a two point scale (1 = eats or 2 = does not eat within 30 seconds). The farmers themselves tested the breeding animals before the breeding season. In addition, the research workers from the University of Kuopio performed feeding tests to all of the cubs in six of the project farms during October-November in both years. In 1995 and 1996, a total of 9617 test records were obtained from adult blue foxes (8685 females and 932 males) and 2339 from adult silver foxes (2037 females and 302 males). The number of cubs tested during those years was 7778 blue and 1936 silver foxes. 6202 reproduction records were available from blue fox females and 1088 from silver fox females. Also 2560 tested blue fox and 562 tested silver fox cubs had pelt-grading results by Finnish Fur Sales.

The heritability of temperament of breeding animals and the association between behaviour and litter size at birth and at two weeks, conception rate, whelping rate, nursing rate and date of heat were estimated using REML in univariate and bivariate repeatability animal models. The heritability of temperament of cubs and the associations between temperament and pelt gradings were estimated using REML in univariate and bivariate animal models.

In both silver and blue foxes, the estimate of heritability for temperament of adult animals was 0.19, the repeatability for silver fox being 0.35 and for blue fox 0.45. In cubs the estimate of heritability for temperament was 0.39 for blue fox and 0.18 for silver fox. In both silver and blue foxes the estimates of heritability for reproduction traits were fairly low, varying from 0.03 to 0.20, except for the date of heat (h^2 = 0.44 in blue and 0.40 in silver fox) which can be considered medium. The estimates of repeatabilities varied from low to medium (r=0.03-0.44) with the exception of date of heat (r=0.65 in blue and 0.71 in silver fox). The genetic correlations between temperament and reproduction traits, except for date of heat and nursing rate, were negative in silver foxes. In blue foxes the corresponding genetic correlations were all positive, even though the

phenotypic correlations for litter size at birth and at two weeks were negative. Fixed effects of sex, age, year and temperature of the testing day were significant on temperament of the adult foxes, on blue fox vixens also the number of days from testing to mating. Fixed effect of temperament was significant on litter size at birth in silver foxes, and on conception rate and litter size at two weeks in blue foxes. The effects were, however, rather conflicting.

NJF Seminar no. 280 / NJF Report no. 116, pp. 219-226, Helsingfors, Finland 6. - 8.10.1997.5 tables, 4 figs., 6 refs. Authors' summary.

Preliminary results from a selection experiment for more confident blue foxes

Hilkka Kenttämies, Kerstin Smeds, Teppo Rekilä

Confidence of farm-bred fur animals towards human reflects welfare and adaptation to farm conditions. In order to increase confidence a Nordic project "Selection for more confident farm foxes" was planned. In 1995, selection experiments with blue foxes were started in a private fur farm in Korsholm. The purpose is to find out whether genetic variation exists in temperament of blue foxes, and association between confidence and fertility and some other production traits.

Material was obtained from the native farm. The base population was divided genetically and on the basis of the production traits into two equal groups: selection and control lines. The experiment has continued within closed lines, and the new breeding animals are selected among yearlings (4-7% of males and 38-52% of females). Each year there are approximately 20 males, 140 females and their cubs in the experiment. Animals in the selection line are selected due to the breeding value for confident behaviour, and those in the control line due to the combined breeding value for litter size, body size, fur quality and fur clarity. In order to maintain genetic variation in the control line, the breeding females are selected from each litter, and males from each sire. Confidence towards a human was defined using a feeding test (eats within 30 sec or doesn't eat).

Repeated tests increased the accuracy of testing, mostly after the first repetition. Correlations between different times of testing were closer in male kits (r=0.647-858) than in female kits (r=0.492-0.680) or in adult animals (r=0.511-0.692). When the same animals were tested in October and the following January low correlations were obtained (r=0.217-0.222). These indicate that seasonal variation exists in behaviour, and that the testing of kits and breeding animals partly reflects different features of behaviour. Among factors affecting the test results confident dams tended to produce more confident progeny than less confident (fearful) ones ($P<0.05$). In addition, males were more confident than females ($P<0.01$).

Confident females obtained larger litters than fearful ones. In 1996, the first selection generation, litter size in the selection line was greater than in the control line. These differences were, however, not significant. These preliminary results indicate that by using selection it may be possible to change temperament of blue foxes towards more confident behaviour, and at the same time to progress in reproduction.

NJF Seminar no. 280 / NJF Report no. 116, pp. 227-233, Helsingfors, Finland 6. - 8.10.1997. 1 table, 1 fig, 15 refs. Authors' summary.

Realised inbreeding in simulated mink populations

Peer Berg

Rate of inbreeding depends on population size and selection criteria among other things. Rate of inbreeding is precisely predicted in unselected randomly mating populations, whereas the rate of inbreeding in selected populations is more difficult to predict. By the use of stochastic simulation, mink populations were simulated under different selection

criteria and the realised rate of inbreeding computed. Rate of inbreeding was simulated:

In unselected mink populations and compared to predicted values at varying population sizes;

In mink populations selected for litter size, weight or quality;

In mink populations with selection on litter size and weight versus weight and quality at varying population sizes.

Rate of inbreeding could be precisely predicted in unselected populations, however the rate of inbreeding was several folds higher in selected populations. The rate of inbreeding increases as the emphasis on categorical trait (quality) and litter size increases. With selection on litter size, weight and quality the rate of inbreeding is 11, 4 and 8.5 times faster, respectively, relative to the rate of inbreeding in an unselected population.

If rate of inbreeding should be lower than 1% per year or generation, population size should be at least 200 females and up to at least 500 females with increasing emphasis on litter size in the selection criterion.

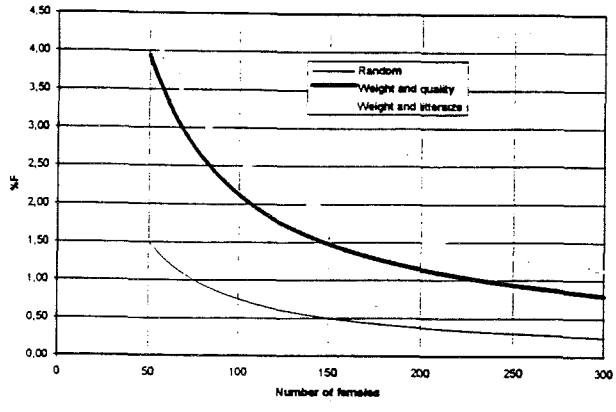

Figure 3. Realized rate of inbreeding under selection for littersize and weight; weight and quality and random selection. Simulated values are not shown, but the fitted curves all have R^2 above 0.95.

NJF Seminar no. 280 / NJF Report no. 116, pp. 235-242, Helsingfors, Finland 6. - 8.10.1997. 1 table, 3 figs., 10 refs. Author's summary.

Mink dam weight changes during the lactation period

Bente Krogh Hansen

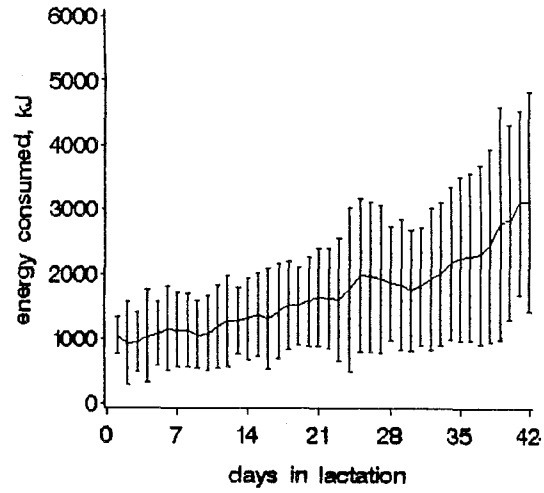

Figure 1. Average daily energy consumption (kJ ± 2*std) of dam and litter in the lactation period.

In the first four weeks of lactation the mink dam produces an average litter weight equalling the dam's own body weight. Thus, during this period the dam's demand on nutrition and energy is high. Records of the daily energy intake of 85 mink dams with 5 to 8 kits in the lactation period were analysed in the years from 1991 to 1994. Furthermore, dam weight changes were analysed based on fortnight recordings on a total number of 570 dams including 786 lactations in the years 1989 to 1994. Both investigations are included in a Ph.D thesis with the title 'The lactating mink (*Mustela vison*) Genetic and metabolic aspects' Hansen (1997a).

During lactation the mink dam is in negative energy balance. Dams are selected in order to give birth to large litters but her lactation capacity and her ability to care for the kits are decisive for the number and the size of the kits at weaning. Although the dam increases her feed intake, she is not able to compensate for the requirement of the litter. Thus, the negative energy balance continues and results in a weight loss of 15% during the lactation period, two thirds of it occurring during the fifth and sixth weeks of lactation.

Direct additive effects and effects of permanent environment were estimated using restricted maximum likelihood (REML) in univariate and bivariate models. The heritability estimates of the direct additive effect of dam weight changes varied from 0.15 to 0.38. The repeatability for weight changes between parities was intermediate to high (r 0.19 to 0.52).

Adult dams lose more weight and intake less feed than yearlings. Dams with heavy litters have larger weight loss, especially during the last part of the lactation period.

NJF Seminar no. 280 / NJF Report no. 116, pp. 243-251, Helsingfors, Finland 6. - 8.10.1997. 1 table, 1 fig., 22 refs. Author's summary.

How to ensure continued progress in litter size

Jesper Clausen

When selecting for litter size, we have normally been looking at the female's own performance and the kits' performance. After introducing computers in the breeding work the litter index is now in use so that several sources of information are included in the selection criterion. This gives a larger security in the breeding work of course and thereby quicker progress. However, as litter size has a low heritability (h^2 = 0,10 - 0,15) we are constantly working at optimising the breeding work as regards litter size.

The article describes how experience from DanMink's Avlsdatabank (breeding data bank) has been incorporated into DanMink so that the individual farmer can include alternative traits and information in his work on improving the litter size. When many different traits/pieces of information are used in the selection for litter size, it is a big problem to find out how much weight is given to the selection for litter size. The article shows how DanMink has made a new module, which helps the farmer to steer the intensity of selection on the traits concerning litter size.

Furthermore, there is a discussion of how management through mating plans and breeding strategies also has an influence on the litter size.

NJF Seminar no. 280 / NJF Report no. 116, pp. 253-254, Helsingfors, Finland 6. - 8.10.1997. In DANH, Su. ENGL. Author's summary.

Microsatellite variation in a sample of Finnish farm foxes

Minna Rintamäki, Jaana Tähtinen

Microsatellites, the short repeated nucleotide motifs, represent excellent molecular markers for monitoring genetic variability, because they are highly polymorphic and abundant, generate discrete genotypes, and they can be efficiently analysed by PCR and gel electrophoresis. In this study, six microsatellites (CPH3, CPH6, CPH8, CPH9, CPH16 and CPH18) were used in analysing a sample of Finnish farm foxes. Data consisted of 75 blue foxes (*Alopex lagopus*) and 74 silver foxes (*Vulpes vulpes*). Approximately 20 individuals per farm were sampled from three blue fox and four silver fox farms in Ostrobothnia, Finland. The aim of this study was to investigate variation between species and between farms within species.

Allele frequencies, degree of polymorphism and heterozygosity were estimated. Comparison of microsatellite loci revealed that they all were polymorphic in both species. In the blue fox, the number of alleles ranged from 5 to 8 and the mean number of alleles per locus was 6.3. In the silver fox, the number of alleles per locus ranged from 4 to 8 and the average frequency of alleles was 5.8. Allele size distributions showed overlapping, but species specific alleles were observed in all loci, especially in CPH16 and in CPH18. The most common allele in all loci was different in each species. The expected heterozygosity within farms varied from 0.528 to 0.646 in the blue fox and from 0.511 to 0.631 in the silver fox. So,

there were no differences in the average heterozygosity between the two species: 0.593±0.057 and 0.597±0.045, respectively. Nei's standard genetic distances were calculated and the corresponding dendrogram was constructed by the UPGMA method. The genetic distance between blue and silver foxes was about 1.8. Between the farms, the distance varied from 0.00 to 0.02 within the blue fox and from 0.03 to 0.11 within the silver fox. According to the genetic distance, it seems that the blue fox populations were genetically more similar than the silver fox populations. In these farms, the number of silver foxes was relatively small, because the farmers have concentrated on producing blue foxes. Thus the change of breeding males between farms was more common in blue foxes than in silver foxes, which may explain the result.

NJF Seminar no. 280 / NJF Report no. 116, pp. 273, Helsingfors, Finland 6. - 8.10.1997. Authors' summary.

Homologue brown mutants of blue fox (Alopex lagopus) in Norway and in Finland

Outi Lohi, Liisa Jalkanen, Kai-Rune Johannessen

Of sudden changes in the DNA in farmed fur animals the mutations in genes affecting the coat colour are the most known. Genetic changes with similar results in the phenotype have also occurred repeatedly and at different farms. In a situation of two unrelated mutant types with similar phenotype it is important to study the genetic relationship between them.

The relation between two brown mutants of blue fox *(Alopex lagopus)* was investigated by a crossing experiment. In 1996, 7 females of the Finnish brown mutant, born at Nahkala's fur animal farm Finland in 1985, were inseminated with cryopreserved sperm of the Norwegian arctic blue type, born at the fur animal farm of Heggem brothers Norway 1978. Only one litter was born with three pups, all of them brown in colour and with blue eyes. In 1997, one of the old females was again inseminated with arctic pearl sperm; four of the others were inseminated with fresh sperm from the brown pup males of the F_1-generation. Three of the last ones produced litters including altogether 20 pups, all of them brown in colour and with blue eyes.

It is concluded that the Norwegian arctic pearl and the Finnish brown blue fox mutant are homologues.

NJF Seminar no. 280 / NJF Report no. 116, pp. 275-277, Helsingfors, Finland 6. - 8.10.1997. In SWED, Su. ENGL. 2 tables, 3 refs. Authors' summary.

GENETIC ATLAS OVER FARMED ANIMALS

The late professor Dr.habil Janusz Maciejowski was the most famous Polish geneticist on fur animals. He was known to a large group of international scientists through many publications and reports at genetic congresses and international fur animal meetings.

While teaching animal genetics at the Agricultural University of Lublin he published books on genetics not only in Polish but also in English. The very last of his literary works was to write the fur animal part to the above mentioned book •Atlas Ras Zwierzat Gospodarskich•, which gives a review of different races and breeds of all domestic animals in Poland

The book is in Polish but with illustrative colour pictures.

Ref.: Outi Lohi

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