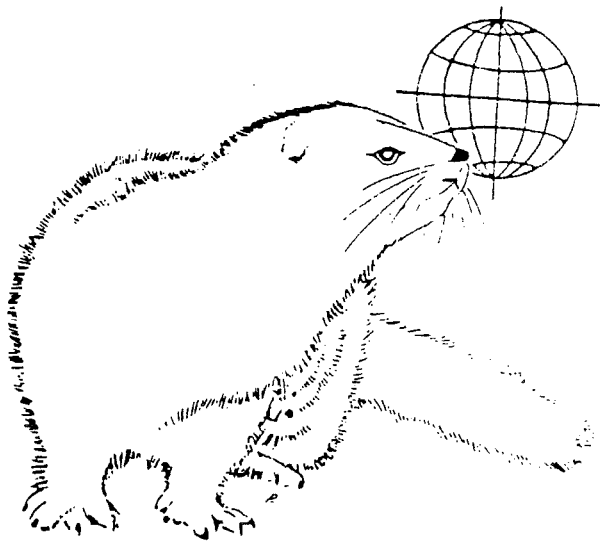

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Titles of other publications - not abstracted

Standard guidelines for the operation of mink farms in the United States. *St. Paul, Minnesota Fur Farm Animal Welfare Coalition, 1989. 16 pp. Monograph. Code 10-11-12-14-M-F-O.*

A comparison of water quality criteria for the great lakes based on human and wildlife health. *James P. Ludwig, John P. Giesy, Cheryl L. Summer, William Bowerman, Richard Aulerich, Steven Bursian, Heidi J. Auman, Paul D. Jones, Lisa L. Williams, Donald E. Tillitt, Michael Gilbertson. J. Great Lakes Res. 19 (4), pp 789-807, 1993. Code 1-8-14-O.*

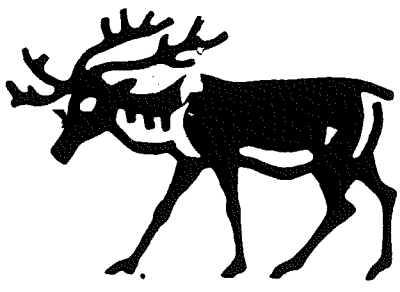
Response of pocket gophers (*Thomomys talpoides)* to an operational application of synthetic semiochemicals of stoat (*Mustela erminea*). *Thomas P. Sullivan, Douglas R. Crump, Hal Wieser, Elisabeth A. Dixon. Journal of Chemical Ecology, Vol. 16, No. 3, pp 941-949, 1990. Code 11-10-3-O.*

Breeding of northern lynxes in captivity. On visit at a Bavarian fur bearing animal breeder. *H. Stangassinger. Deutsche Pelztierzüchter (Germany), Vol. 66 (6), pp 122-123, 1992. 5 ill. In GERM. Code 1-4-12-O.*

The lobby of chinchilla breeders in the Federal Republic of Germany. *H.H. Tröger. Deutsche Pelztierzüchter (Germany), vol. 66 (2), pp. 31-32, 1992. In GERM. Code 14-O.*

Production of mink. *L.F. Gosalvez Lara, P. Diaz Jemenez. Hojas Divulgadoras-Ministerio de Agricultura, Pesca y alimentacion, No. 11, 32 pp, 1991. In SPAN. Code 14-M.*

Chinchillas - tricky business with fur bearing animals. *K. Widemann. Top-Agrar-Spezial Für Mecklenburg-Vorpommern, Brandenburg, Sachsen-Anhalt, Sachsen, Thüringen (Germany, F.R.); Das Magazin für moderne Landwirtschaft, No. 1-2, pp 22-25, 1991. 1 ill., 1 table. In GERM. Code 12-13-14-O.*



4. Genetics

Titles of other publications - not abstracted

The brevicaudata chinchillas. *Giovanni Mischi. Rivista di Coniglicoltura (Italy), Vol. 28 (4), pp 26-27, 1991. In ITAL. Code 4-14-O.*

5. Reproduction

Titles of other publications - not abstracted

New information on periovulatory endocrinology in the blue fox. *M. Mondain-Monva., N. Lahlou, A.M. Piot, W. Farstad P. Hyttel, A.J. Smith, R. Roger. Pathologie Biologie 39, 10, pp 1015, 1991. In FREN. Code 3-5-F.*

6. Nutrition

Titles of other publications - not abstracted

Chinchilla, the feeding in practice. *Anonymous. Rivista di Coniglicoltura (Italy), vol. 27 (12), pp 51-52, 1991. In ITAL. code 6-7-O.*

7. Veterinary

Titles of other publications - not abstracted

Recurrent *Mycobacterium bovis* infection following a ferret bite. *J. Wynne Jones, J.v.S. Pether, H.a. Rainey, C.R. Swinburn. Journal of Infection 26, 2, pp 225-226, 1993. Code 9-12-14-O.*

Diagnosis of urolithiasis in mink. *V.B. Nakonechnikov. Krolikovodstvo i Zverovodstov, No. 2, 25, 1992. In RUSS. Code 9-M.*

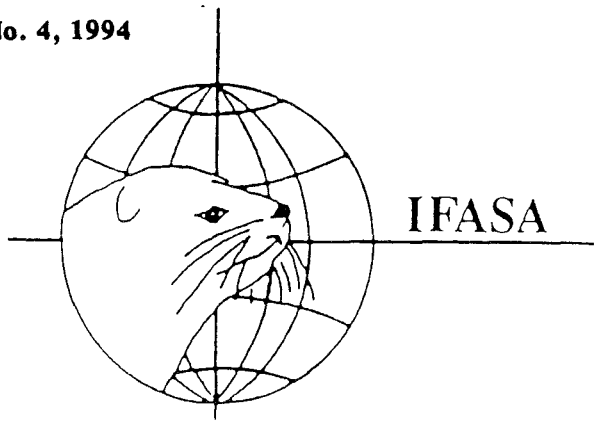
Cervical chordoma in two fererts (*Mustela putorius furo*). *B.H. Williams, J.J. Eighmy, M.H. berbert D.G. Dunn. Veterinary pathology 30, pp 204-206, 1993. Code 9-O.*

Some aspects of dermatology in pets other than dogs and cats. *M Fehr. Kleintierpraxis 37, 6,pp 393-396 + 401, 1992. In GERM. Code 2-9-O.*

Characteristics of Pseudomonas aeruginosa cultures discharged from polar foxes. *P.F. sonin, N.P. Ledovskikh. Sbornik nauchykh trudov - Leningradskij veterinarnyj institut (USSR), No. 101, pp 140-145, 1989. IN RUSS. Code 9-8-F.*

Some diseases of the chinchillas. *Anonymous. Rivista di coniglicoltura (Italy), vol 28 (3), pp 25-27, 1991. In ITAL. Code 9-12-O.*

Mink enteritis. *C.R. Parrish. Veterinary diagnostic virology a practitioners guide (edited by Castro, A.E; Heuschele, W.P) pp 191-193, 1992. Code 9-M.*



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IFASA

Notes
SCIENTIFUR
Vol. 18, No. 4, 1994

Seeing the figures for the increase in skin production in 1994, one must realize that the fur breeders themselves are perhaps even more optimistic than the people on the marketing side. Surely we all hope that the optimism regarding the prices for the 1994 production will be supported by the future skin prices.

We in IFASA and SCIENTIFUR realize that the time for a costly increase in activities and for "pepping up" SCIENTIFUR is much further ahead that we expected a few years ago.

At the IFASA Board meeting in Holland on November 11th, 1994, it will surely be confirmed that member fees for IFASA and subscription rates for SCIENTIFUR will remain unchanged in 1995. This way we hope to increase both the number of members and of subscribers.

At the end of September, the annual scientific meeting of the Scandinavian Association of Agricultural Scientists, Division for Fur Animals, took place in Denmark. A lot of valuable scientific facts were presented for an audience of more than 90 scientists, advisers etc. In the next issue of SCIENTIFUR we will bring abstracts from this seminar. In this issue of SCIENTIFUR you will find a full length review of the results of the Scandinavian ethological research with foxes in recent years.

We already have a lot of important information ready for the 1995 volume of SCIENTIFUR. Information which is important to you as well as to your colleagues. Please tell them.

As already mentioned in SCIENTIFUR No. 3 we are still in business only because of The Council of European Fur Breeders Associations (CEFBA). The Council has this year sponsored more than NOK 200,000 for the production and distribution of SCIENTIFUR.

We are very grateful to CEFBA for this contribution, to Schering-Plough Animal Health Division for their support in advertising, to our subscribers, and to our contributors who help us make SCIENTIFUR such a valuable source of information.

To Oslo Fur Center housing our office, to Copenhagen Fur Center printing our journal, to Research Centre Foulum, Dept. for Small Farm Animals still giving me room for finishing the lay-out of SCIENTIFUR, and last but not least to the "old" guard Dorthe, Jytte, Hanne, and Janne, all in Denmark, I would like to extend my warmest thanks for their invaluable cooperation in typing, book keeping, language adjustment, production, and distribution.

ALL OUR READERS ARE HEREBY ASKED TO ACCEPT OUR SINCERE THANKS FOR YOUR COOPERATION AND HELP IN 1994, AND AT THE SAME TIME PLEASE ACCEPT MY BEST WISHES FOR A MERRY CHRISTMAS AND A HAPPY AND PROSPEROUS NEW YEAR.

Your grateful editor,

Gunnar Jørgensen
still happy in Norway

IFASA

Dear colleagues !!!!

Meeting at our international IFASA-congress each 4th year we always realize how important the close contact with colleagues all around the world is. But how to keep these contacts up frequently also between the congresses.

With the modern electronic technique we have new possibilities. I guess that many of us are already connected to some international network of computers, which makes it possible to reach colleagues by electronic mail. There are also many discussion groups transmitting information through these networks.

What about starting a discussion group on fur animal research on Internet ????

It would give a good possibility to exchange information on research projects, results, questions to ask the colleagues etc.

Let us hear how many of you have connection to Internet and whether you are interested in establishing a Fur Animal Discussion Group.

Send your answer to:

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Original Report (Review)

Production Conditions, Behaviour and Welfare of Farm Foxes

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Preface

This paper is the final report on the NKJ-project no. 78 "Welfare of farm fox". It is the responsibility of each of the authors, who are mentioned in alphabetic order. It is a review of the conclusions of the many scientific papers produced as a result of the NKJ-project and some previous papers on the topic. A complete list of these scientific publications is included. This paper adresses fur breeders, fur breeders organisations, public decision makers, and interest groups.

History of farm foxes

The farm production of foxes started in North America at the end of the 19th century. Animals from that production came to Norway in the beginning of this century and somewhat later to Denmark and Finland. The two species involved are: the silver fox, which is bred from the common red fox (*Vulpes vulpes*) and the blue fox, which is bred from the arctic fox (*Alopex lagopus*). Both species are now found in a numerous variety of colours. Both species differ morphologically and behaviourally in numerous ways from the original wild living types.

The Biology of the Wild Living Types

The knowledge of the biology of wild living or feral types can be a good inspiration for research regarding production routines and housing conditions for the husbandry animals. Knowledge of the biology of the wild living types of foxes has been crucial for the welfare research that has been initiated in this area. For example: the research on early contact is based upon the knowledge of imprinting; the research on cub-loss and neighbour relations is completely dependant on the latest knowledge of the social structure of foxes in the wild; the research on year-round nesting boxes agrees well with the knowledge of living conditions of wild foxes.

Production Environment

Typically, farm foxes are kept in metal wire cages. The area of the bottom varies from 0.6 to 1.2 m^2, the height is either 0.6 or 0.75 m. The smallest cage is normally used for the blue fox which is the smallest of the two species, and seems to be the calmest in the present production environment. From the onset of the mating season until the weaning of the cubs, the cages are equipped with a nest box (breeding box).

The remainder of the year the cages are without any furnishing. The mating season begins in the early spring, starting with the silver foxes and ending with the weaning of the last of the blue fox cubs in the course of the summer. The silver foxes wean 2-4 cubs per mated vixen, the blue foxes approximately twice that number. The cubs are kept in pairs or single until pelting, which takes place in December. Farm foxes are fed in the same way as mink, with wet feed from commercialized feeding kitchens. Raw material for the feed is primarily waste from fish and slaughter industries. Foxes for pelting are killed at the farm. The foxes are put to death instantaneously with electricity, which is sent from the head region to the anal opening.

The present production environment developed from larger ground enclosures with many foxes, primarily as an adaptation to avoid illness and bad hygienic conditions. It has remained unchanged for the last 40 years or so.

Laws and Rules

Farm fox production is controlled by the "European convention for the protection of animals kept for farming purposes", by the "Recommendation Concerning Fur Animals" of October 19th 1990 as part of this convention, and by the European Fur Branches Code of Practice. In Denmark there is a law concerning the raising of game and foxes, as well as a Veterinary Directorate recommendation number 236 from December 10, 1993, concerning the raising of farm foxes. In Norway the welfare of farm foxes is controlled by the general law on animal welfare (No. 73) of 20th December 1974. No specific regulations or recommendations on fur animals has yet been given, but such will probably appear within a few years. Finnish regulations (Directives by the Ministry of Agriculture and Forestry 787/85) include detailed directives on farm constructions, cage size, group size, farm hygiene, etc. The European Convention has the broadest visions for changes in the production routines and housing conditions in fox production. It recommends early human contact with the fox cubs and year-round nesting boxes as important improvements for the welfare of the farm foxes.

Apparent Welfare Problems

From time to time the production of farm foxes is subject to public critique in the Nordic as well as in other countries. This critique mostly originates from interest groups and their opinion of the animals' living conditions. Even though this attitude is a real political factor, is does not necessarily reflect the welfare conditions the way the animals see them. EU has published a report that compiles such attitudes (Study of the legal, technical and animal welfare aspects of fur farming. ISBN 92-826-0504-3). The most frequent brought forth complaints are that the foxes are kept in cages, that the cages are small and without furnishing, that the foxes are caught with tongs, and that they are generally fearful and have reproduction problems. Based on our present scientific knowledge the critique against the caging as such and the use of tongs is not justified. On the other hand, however, the critique regarding the animals showing fear towards humans, the reproduction problems and the lack of cage furnishing is in agreement with present scientific results.

Stress and welfare

Good welfare is regarded here as a state of physical and mental health in which biological needs are fulfilled. Animals have needs for good food and pure drinking water, and may in the same way have needs for proper social contact, a secluded area or species-specific occupation, just to mention a few examples. Illness, food and water shortage, damages, pain, over-stimulation, under-stimulation, and long term stress obviously have to be avoided in order to provide good welfare.

Stress is the organism's reaction to, or preparation for reaction to, a physical or psychical demanding situation, as for instance a fight with a rival, an escape from a predator, or a courtship situation. Not all of such situations which elicit stress are bad for the organism, and an acute stress reaction to a challenge is a healthy biological reaction. An appropriate number of stressing experiences may be part of a good welfare situation.

However, in situations in which stress is elicited very often or permanently, stress in itself becomes a threatening condition for the animals. This happens for instance when farm animals are kept at too high densities or in permanently poor environments. Such long term stress is reflected in a number of physiological and behavioural changes, for instance high base levels of plasma cortisol and urinary cortisol, enlargement of adrenal glands, gastric ulceration, increased body core temperature, impaired immune defence, increased fear, reduced growth, and reproduction failure. Absence of these signs of long term stress may be taken as signs of good welfare.

Naturally we can not use the absence of just one parameter as sign of good welfare, and the context of the measurement has always to be taken into account. For instance, base levels of cortisol can be obtained only when the animals are not acutely stressed, which they are as a result of a blood sampling just a few minutes after the onset of the sampling procedure, or which they may be as the result of any previous disturbance. Reproduction failure is a natural consequence of long term stress, and a useful measure of welfare in experimental comparisons of, for instance, two housing systems: All other things being equal the system with the best litter size should also provide the best welfare. On the other hand, increasing the litter size by some generations determined selection for that trait need not be followed by an increase in welfare. Comparable reservations apply to pelt quality as a measure of welfare, and many other measures.

The safest way to have a reliable estimate of welfare is to count on the context of the measurement and to use several measures, preferably both physiological, immunological and behavioural.

Concluded and Present Research

The behavioral research aiming towards emphasizing the welfare of farmed fur animals was started in Norway in 1983 quickly followed by Denmark and Finland. It was started at the initiative of the researchers, but from the very beginning significantly supported by the national fur breeders' organizations. From 1990 until 1993 the efforts were co-ordinated and strengthened by a NKJ grant to Norway, Finland and Denmark. Presently, research is continuing on a national level but with considerable international co-operation which now includes Holland. In Denmark the research department of the Ministry of Agriculture has provided means for the research within the program "Farm animal welfare, production system and production-related diseases". This program ends in 1996. The Research council of Norway supports the project "Implementation of individual variation in behaviour of silver foxes" until the end of 1994. In Finland the Research Council of Agriculture and Forestry has financed a 3-year research project (1994- 1996) on "Measuring behaviour and welfare of farm foxes". The following list of litterature include the main part of the litterature on behavioural aspects of welfare and production of farm foxes. References to the list will be given by numbers. Braastad gives a comprehensive review of the ethology of farm mink and farm fox (102).

Production routines, the relationship between man and animal

Capture methods

Farm foxes normally live undisturbed in their cages, but have to be caught and handled in the process of moving, when measuring oestrus, mating, fur grading and possible medical treatments. Breeding animals are moved on the average twenty times a year, cubs up to five times before pelting. The most frequent method of handling the animals is to take them with tongs around the neck and then grab them by the tail. Outside the cage the foxes are held in such a way that their abdomen is resting on the leg of the farmer. Animals that resist handling will often bite at the tongs and in rare cases hit their gums on the tongs or break a tooth. This can be prevented by putting rubber tubing on the tongs. An alternative method is to grab with one hand under the chest and the other around the tail. When using this method outside the cage, the fox is held close to the handlers chest. This creates a potential risk for biting injuries in the face, by animals that resist handling. The alternative method is somewhat slower and demands more skills. It is also difficult to practice in larger cages.

The two methods' impact on the animals stress levels and safety of the caretaker has been thoroughly investigated by measuring the foxes heart rate changes as an expression of acute stress. There was great individual variation in

the animals' stress reaction and the variation was only marginally affected by the two capture methods. The silver foxes were somewhat more stressed when they were caught with the tongs and the blue foxes somewhat less stressed when caught in this manner. The silver foxes were a greater risk for the caretaker when they were caught by hand. There was no difference in the capture methods for the caretakers safety, as far as the blue foxes were concerned. The conclusion is that there is no reason, from an animal welfare point of view, to prefer one method over the other. Both methods cause moderate levels of acute stress in the animals. (95, 96, 99, 114, 118).

Early experience with humans and farm environment

The wild foxes adapt to periods of abundance by maximising their reproduction in that all vixens are mated. In periods of scarcity the foxes adapt in such a way that the lower ranking females in the social hierarchy become helpers for the dominant. The dominant vixens continue to produce offspring but the helpers either do not reach oestrus, abort, or eat their cubs. The low ranking vixens in a group are often younger sisters or daughters of the dominant or otherwise related and achieve, through their helping activities, a more efficient distribution of their genes than if all the vixens had competed and lost in such a competition. This had led to the hypothesis that the helping strategy is a genetically based behavioural potential in the fox. (12, 13, 14, 30, 53, 75, 76, 101, 119, 120, 121, 215, 216).

The farm foxes can likewise minimise their reproduction when they are disturbed in the breeding period. This has resulted in the farmer's routine to avoid being on the farm as much as possible while the cubs are small and to make nesting boxes with maximal protection against disturbances. However, this can cause other and worse problems, because in this situation the foxes will not be imprinted on humans and the farm environment while they are still capable of being imprinted.

Foxes have an early sensitive period for socialisation and they can during this period become permanently imprinted resulting in that they as adults show less fear of humans and show more confidence towards the farm environment that they are a part of. These issues have been thoroughly investigated in a recently concluded Ph.D. project (140), and in a number of other projects. The reports confirm that proper early experience is beneficial for the welfare of the foxes and their reproduction results. Furthermore, it is shown at which age the fox cubs should be influenced and how it should be done. The age from six to eight weeks is the best time, but they are also sensitive to experiences earlier and later. Ordinary routine capture and handling of animals is an effective early experience. (36, 37, 47, 49, 61, 67, 73, 97, 116, 134, 208, 209, 210, 211).

Later animal-human contact

Daily contact with the farm foxes by handlers is also of great importance for their welfare (122, 123, 128, 139). First and foremost it is important that the contact is made daily. It has been shown that a handout, for example a biscuit, together with the daily inspection can enhance the human-animal relation. This quickly reduces the animals' fear of humans and it improves the reproduction in multiparous vixens (104, 122, 203, 215).

Thorough investigations have also shown that the foxes' expectations regarding their contact with humans is of significance as to degree of experienced stressfulness. In an experiment the feeding and the daily care was performed by a person wearing blue whereas the capture and the handling was done by a person wearing white. After a period the foxes were "tricked" by letting the blue-dressed person do the capture and handling. At first the foxes displayed stress reactions, but got accustomed to both persons, naturally more and faster to the blue-dressed person. The highest stress reactions in the experiment were triggered when the blue-dressed person, contrary to the expectations of the foxes, did the capture and the handling (123, 129). The experiment shows that the proper daily care in itself is a potentially important means in improving the welfare of the farmed fox.

Housing conditions, physical environment

Cage size

The effect of the size of the cage on the foxes' behaviour has been investigated. In an experiment with one fox per cage the cages used varied from 1 m2 to 8 m2. This only marginally affected the foxes' behaviour, except that the animals displayed more active escape behaviour

toward the observer when in the large cages. The silver foxes accustomed themselves to the situation and gradually reduced their escape behaviour. The blue foxes, however, did not although the conditions of the experiments were identical. This is only one of many indications that the two species are different. With increased knowledge we will undoubtedly have to evaluate their welfare conditions as different (211).

Some pilot studies have been carried out in large enclosures with a variety of furnishings such as: nest boxes, shelves, sand boxes, branches and balls. Both species can manage in these environments, but they develop more fear of humans than foxes kept in conventional systems, unless they are subject to a much more intense human contact. The experiments suggest that the keeping of farm foxes as husbandry animals require systems that allow frequent contact between humans and animals (67, 68).

In experiments that allowed farm foxes to choose freely between being in conventional cages or in 8 m^2 enclosures on the ground, the animals showed no clear preferences (206).

The experimental results that are presented above are for many reasons difficult to interpret. They do point out, however, what is also known from more conventional husbandry animals that the cage size as such, is not critical for the animals' welfare. Also size, or a combination of size and furnishing, can allow the animals such infrequent contact with humans that they become almost feral.

Cage bottom types
The conventional wire cage has been the subject of considerable critique because many people feel that it is unnatural and must be unpleasant to walk on a wire bottom. For this reason considerable funding has been spent to investigate this point. Repeated experiments show that adult foxes distribute their time equally between a solid bottom and wire bottom, regardless of experimental design and number of months duration. The conclusion is that it is not aversive for adult foxes to walk on wire bottoms. However, cubs avoid walking on large meshed wire bottoms while their paws are still small and the coordination of their muscles are not fully developed. The cage system should therefore be partially equipped with a solid bottom or a fine meshed wire, out of concern for the younger animals (67, 68, 205).

Breeding boxes
Experiments with breeding boxes show that a tunnel in front of the nest box improves the reproduction for both species. This is especially the case for primiparous vixens and on farms where the reproduction results have not been good. The effect is probably that the vixens feels more secure and undisturbed by the farm environment. Behavioural studies show that the vixens are calmer and do not investigate their surroundings as often. In this situation it therefore seems likely that vixens who give birth and lactate experience a better welfare when they have an entrance tunnel. (3, 8, 9, 11, 15, 17, 19, 23, 28, 31, 33, 54, 56, 64, 79, 80, 103, 125, 126, 204). The normal procedure in opening the breeding boxes or taking away the tunnel when the cubs reach 3-4 weeks should assure that the cubs achieve adequate and sufficiently early contact with the surroundings in order to gain optimal imprinting. The system is thus no hindrance for the welfare of the cubs at a later stage.

The fox cubs in their first few days of life have insufficient heat production. They are totally dependant on warmth from the vixen. They can reduce their heat loss by huddling together. However, extra insulation of the nest box makes no significant difference in the heat loss rate of the cubs. Experiments with small infra-red lamps show that the cubs seek such heat sources and heating of the bottom of the breeding box can undoubtedly prevent some cubs from dying of heat loss. However, from the welfare point of view, it seems more proper to avoid that form of cub loss by choosing vixens with good maternal qualities and provide them with properly constructed breeding boxes which give them a secluded atmosphere to tend their litter. (70, 82, 83, 84, 108).

Year round nest boxes and observation platforms
It has been suggested from different parties that adult foxes should have the opportunity to protect themselves from bad weather during the winter in a winter nest box, or an all-year round nest box, or a shelf with sides and a solid bottom. However, thorough thermophysical experiments with animal models, either with or without fur, show that such a need does not exist. On a model animal with fur the heat loss is only

10% less when the model is lying in a nest box compared to when it is lying exposed in the cage. A well-insulated nest box can halve the heat loss from a "naked" model. For comparison, the effect of the fur coat only is more than six-fold. The fur provides a fine and adequate insulation. Extra insulation has only a very limited effect, regardless whether it originates from a nest box or a shelf. Heat loss through the different sides of a nest box has been investigated. Nearly all of the heat loss is through the bottom of the nest box, so if the nest box should be provided with extra insulation, it should be put there. Wooden shelves provide better insulation that wire shelves, however, that is only the case when they are dry, which they sometimes are not. Therefore, the wire shelf will usually provide the best insulation, partly because they do not need to be re-heated every time the animal returns to it and partly because the fur is less compressed on such a shelf. These results were achieved with animal models that were stretched out on the abdomen, on the shelf, or on the floor of the nest box and even in this situation the absolute heat loss was so limited that it cannot be of any importance to the animal. A farm fox will always rest curled up on the side and thus reduces the heat loss from the abdomen, where the fur is thinnest. The conclusion from these experiments is that farm foxes do not need these cage furnishings in order to protect themselves from the cold. (38, 39, 44, 63, 70, 84).

However, several indications show that they benefit from some kind of cage furnishing, into which they can seek shelter when they are disturbed by humans or by neighbours, and a place from where they can observe their surroundings. A shelf placed high can possibly provide both means (86, 131).

In an experiment where silver foxes were kept for several years in cages with three different nest boxes and a shelf, or kept in empty cages, several autumn measurements showed that cortisol, fear, and other measures of stress levels were reduced in animals provided with nest boxes. It was also shown that the animals fled toward or into their nest boxes whenever purposely disturbed by humans. This experiment shows, and the experiments mentioned above with entrance tunnels to the breeding boxes show, that the adult silver foxes may benefit from a cage furnishing which provides shelter all year round (86, 110, 137). Some shorter lasting experiments have not been able to confirm the correlation between welfare parameters and access to shelters or observation platforms (138).

In the blue foxes, mass and quality of fur was poorer in animals having had resting platforms since weaning (217). There was a negative correlation between fur quality and amount of platform use. In silver foxes, fur quality was negatively affected by access to whole-year nest boxes (106). This poorer fur quality, especially of the ventral side, can be explained by mechanical wearing. Whole-year platforms did not affect reproductive performance in blue foxes (218).

Preference experiments clearly show that both fox species prefer nest boxes placed high for year-round use. They also prefer nest boxes with multiple compartments but in spite of this clear preference silver foxes will rather have a nest box with one room and a shelf in front than a two-roomed nest box. In this case the shelf probably functions as an observation platform (205). Many other experiments and observations show that farm foxes seek out places from where they can best observe their environment. The same goes for the wild foxes. Evidence shows that farm foxes prefer platforms without walls more than platforms with walls. (86, 89, 90, 130, 131, 141, 143).

Many investigations have dealt with how often year-round nest boxes and shelves are used, and it turns out that the use is correlated with many different factors. For example, it is related to the time of the year, temperature, disturbances and time of the day. There are great individual differences in how much the shelves and boxes are used and the average use can vary from 0 to more than 50% of the day when observed for week long periods. (25, 26, 41, 45, 48, 62, 67, 81, 85, 87, 92, 93, 94, 105, 106, 113, 130, 131, 137). There is general agreement that the frequency of the farm foxes' use of shelves and boxes does not necessarily express the magnitude of their need for such equipment. The fact that the farm fox "knows" that it has a refuge and an observation platform, can be of great importance for it, even though it does not use it often.

Housing conditions, social relationships

Group sizes

In Denmark experiments have been carried out with both species of farm foxes kept in group sizes of 1,2,4 and 8 animals from weaning until pelting. The housing ratio was in all cases one animal per m^2. Concerning the silver fox there were some problems with biting damages in the large groups (in 12.5% of the large groups one animal was wounded). All groups had higher growth rate, more activity and apart from the few biting injuries there was no significant difference between the groups in fur quality or fur damages. Concerning the blue fox there were no differences between the group sizes regarding growth rate and fur quality. The activity level was highest in the animals kept in groups. Group keeping of young farm foxes is thus a possibility and it is a potential means of creating a dynamic environment for the animals (211). Earlier Finnish and Polish examinations suggest that group housing impairs fur quality (1a, 49a).

Blue foxes have been kept in large enclosures in groups of varying combinations. This is possible until the onset of the mating season. The groups develop a hierarchy that prevents injurious fighting until the beginning of oestrus. Thereafter, the subordinate animals are dominated violently causing injuries. In groups with multiple vixens it is usually only one that weans cubs. This is because the subordinate animals either do not enter oestrus or lose their cubs by abortion or by careless nursing (87, 90).

Neighbour relations

Experiments with silver foxes have shown that they influence each other when kept in conventional farm systems where only wire walls separate them. This influence is dependent on the vixens temperament which can be described by the help of investigation methods by which the vixens are made to compete, for example, for feed (12, 13, 14, 27, 29, 30, 51, 100, 101, 119, 120, 201, 214, 215, 216). Some vixens have a high capacity for competing: often they will also defend themselves against humans who try to handle them. They seem to be self-assured and often become dominant in longer lasting neighbour relations. These animals will henceforward be labelled as "high status animals". Other vixens have a low capacity for competition: they will most often try to escape when they are handled. They appear afraid and are often subordinate in relation to neighbours. These animals will be labelled as "low status animals". The adult vixens' temperament and reproduction capacity can to a significant extent be predicted on the basis of the temperament they shows when they are just a few months old (50, 52, 52a).

Generally, the low status animals get fewer cubs, but it appears that the neighbour relationships of the animals have a decisive influence on this matter. When high status vixens have low status neighbours then the high status animals wean large litters with more male cubs than female cubs, however, the female cubs in this situation thrive better than their brothers. The low status vixens either do not give birth or wean small litters. When high status animals have high status neighbours they give birth to smaller litters that predominantly consist of female cubs that develop slower than their brothers. When low status vixens have low status neighbours they give birth to and wean litters of moderate size; however, smaller litters than from high status vixens with high status neighbours. These results correspond with the hypothesis that farm foxes are predisposed to develop helpers in the social hierarchy. (20, 21, 23, 53, 119, 120, 121, 201). The results and hypotheses are included in a recent Norwegian Ph.D.-thesis (215).

The existence of these neighbour effects on the reproduction makes it natural to investigate whether isolation, for example visual isolation of the vixens in the mating season, would improve the whelping result. At a large research farm with generally good whelping results, it has been shown that visual isolation with a dividing wall between the cages in a traditional cage system does not benefit the reproduction (22). In other experiments with poorly reproducing vixens it has been shown that visual isolation combined with increased distance between the cages has improved the reproduction. The poorly reproducing vixens that participated in the experiment were either vixens that had previously killed their cubs or were low status vixens. The reproduction result of high status vixens is better when they have low status neighbours than when they are isolated (100, 101, 121).

Reproduction problems

Lack of oestrus and poorly completed pregnancy and nursing is a common phenomenon among

farm foxes. A part of the cubs loss during the nursing period is caused by the vixens themselves eliminating their offspring. This occurs in most cases immediately after birth or in the days succeeding, while the cubs are inactive and dependent. This behaviour often begins by biting the cubs' tails or legs. Dead cubs will, regardless of the cause of death, be treated as prey and be eaten, usually within some hours. The vixens who perform this behaviour when primiparous, will with all likelihood continue to do so at later parturitions if they are kept in the same environment (3, 8, 10, 11, 15, 17, 103, 126, 215).

Apparently one can not breed out of the reproduction problems only through traditional selection. If this was the case, then natural selection and artificial selection in the farms would have already contributed to reducing the problems significantly. It seems as if a new understanding and new methods must be used to solve these problems. The above mentioned studies of temperament and neighbour relations may be of importance here. If it is primarily the relation between neighbours which is the problem, then selection on an individual basis can not solve the problems. The combination of the selection against fear on the one hand and an improved farm environment (including maternal environment) on the other, could be a step in the right direction (51, 201, 213, 214, 215). It is the fearful vixens that loose most cubs. If their number is reduced by selection and the number of self-assured animals is increased, it will somewhat improve the situation. The self-assured animals however, can not be close neighbours without stressing each other considerably. A better set-up of the farm environment with for instance all year-round nest boxes, partial division between the cages, or an increased inter-individual distance may solve this problem.

Practical Evaluation of New Farm Systems

Many of the suggestions for improved farm environment that research has presented, are now being evaluated on a large scale in a Dutch-/Danish longitudinal study. One hundred and thirty six foxes of each species are distributed in three different housing systems: the conventional cage system with 1 m^2 per vixen, a modified cage system measuring 2 m^2 with shelves, year-round nest boxes and partially solid-covered bottoms, and finally an enclosure of 4 m^2 with a solid bottom, a sand box, shelves and year-round nest boxes. This study terminates in 1996. Ongoing work in Finland also aimes at the implementation of the research results into common farming practice.

Perspectives for New Research

Of cause many of the topics which have been dealt with up to now is not fully concluded, and many new topics can arise in the future. Continued research on capture methods, group sizes, and communication can be mentioned as examples. The possibility that different individuals or groups of individuals will demand different housing conditions and daily management should also be considered. However, two topics seem very important to get on with in order to obtain an overall understanding of the welfare of farm foxes and an improvement of the welfare, and these are "selection against fear" and "behavioural strategies".

Selection against fear

Continuous fear is an expression of reduced welfare. Anyone would immediately perceive this through analogies to their own feelings. Fear, however, is also a scientifically based expression of reduced welfare because it is a reliable expression of long-term stress. Selection against fear and selection for curiosity and self-esteem will undoubtedly improve the welfare for the coming generations of farm foxes. Such selection is possible which has been shown in comprehensive and longlasting Russian experiments from the Novosibirsk group (and shorter lasting Nordic repetitions: 67, 74, 98). It demands, however, continuous research to assure that a balanced selection can be carried out which in no way will harm the animals. To some extent reduced fear will possibly also improve the farm foxes' reproduction.

Behavioural strategies

It has long been known that animals living in the wild as well as husbandry animals can have two different reactions to stress. One of the reactions is primarily mediated by the adrenal medulla and the behavioural expression is an active forthright meeting of the stressful situation. The other reaction is primarily mediated by the adrenal cortex and is expressed mainly in passive and reserved or avoiding reaction towards the stressor. The first reaction is typical toward

shorter lasting stressful situations; the other towards longer lasting. These reactions have been called short-term stress and active adaptations opposed to long-term stress and passive adaptation. Presently a picture emerges, however, of some individuals in a population primarily expressing one of the reactions whereas other individuals express the other when they are under stress. It is speculated that the two kinds of animals utilize different genetically based behavioural strategies, being either active or passive.

With respect to the farm foxes there lies a clear research assignment in investigating the relationships between the phenomena active vs. passive behavioural strategy; self-esteem vs. fear; dominance vs. subordinance; reproducing individual vs. helper. The degree of correlation between these phenomena should be clarified and their relative dependence on genetic, maternal and other environmental factors should be determined. Research on these topics will give us a better background for understanding and improving the welfare of the farm foxes.

Publications

1 Braastad, B.O., 1983. Anvendelse av atferdsstudier i pelsdyrforskningen. NJF-seminar om pelsdyr, Malmö, 3.-5.83. 8 s.

1a Moss,S. 1983. Siniketun Häkkikokeet. Turkistalous 55, 479.

2 Braastad, B.O., 1984. Anvendt etologi i pelsdyrforskningen. Aktuelt fra Statens fagtjeneste for landbruket, nr. 3, 399-404.

3 Braastad, B.O., 1985. Erfaringer fra videostudier av revetispas morsatferd. Forskermøte i NJF's subseksjon for pelsdyr, Mastemyr (Oslo), 29.-31.1.85. 15 s.

4 Braastad, B.O., 1985. Pelsdyras sosialatferd - kunnskaper som kan utnyttes av pelsdyroppdretteren. Norsk Pelsdyrblad, 59: 347-352.

5 Barlaug, K., 1986. Atferd og fryktreaksjoner hos sølvrev. Hovedoppgave ved Institutt for fjørfe og pelsdyr, NLH. 156 s.

6 Braastad, B.O., 1986. Atferds- og miljøstudier av rev i Norge pågående prosjekter og planer for de neste åra. Forskermøte i NJF's subseksjon for pelsdyr, Reykjavik, 24.-25.4.86. 12 s.

7 Braastad, B.O., 1986. Atferd omkring valpinga hos sølvrevtisper (Vulpes vulpes L.) i pelsdyrfarmer. VII. Nordiske Etologisymposium, Sem, 12.-15.8.86, s. 9-11.

8 Braastad, B.O., 1986. Atferdsstudier i relasjon til reproduksjonen hos rev. NJF-utredning/rapport nr. 27 (22): 1-14. (+ i Finsk Pälstidskrift 20: 657-660)

9 Braastad, B.O., 1986. Sølvrevtispas atferd omkring valpinga. Aktuelt fra Statens fagtjeneste for landbruket, nr. 5, 75-79.

10 Braastad, B.O., 1986. Skadebiting av valper hos sølvrevtisper. Norsk Pelsdyrblad, 60: 147-149, 157. (+ i Våra Pälsdjur, 57: 186-189, 1986.)

11 Braastad, B.O., 1987. Abnormal behaviour in farmed silver-fox vixens (Vulpes vulpes L.): Tail biting and infanticide. Applied Animal Behaviour Science, 17: 376-377.

12 Bakken, M., 1988. Effekt av sosial status på morsegenskaper hos sølvrev. Aktuelt fra Statens fagtjeneste for landbruket, nr. 1, 440-445. (and in Norsk Pelsdyrblad 62 (3): 17-19, 1988; Finsk Pälstidskrift 60: 362-363)

13 Bakken, M., 1988. Effekt av sosial status på morsegenskaper hos sølvrev. Forskermøte i NJF's subseksjon for pelsdyr, Kalmar, 20.-21.4.88.

14 Bakken, M., 1988. Kan vi ved etologisk forskning forklare grunnleggende reproduksjonsegenskaper hos sølvrev? Kalottkonferansen om pelsdyr, Pello, 21.-22.9.88.

15 Braastad, B.O., 1988. Sammenhengen mellom atferd og reproduksjonsresultater hos rev. Aktuelt fra Statens fagtjeneste for landbruket, nr. 1, 422-427. (and in Norsk Pelsdyrblad 62 (3): 19-20, 24, 1988; Våra Pälsdjur 59: 180, 182-183, 1988; Finsk Pälstidskrift 60: 366-368, 1988)

16 Braastad, B.O., 1988. Databearbeiding og statistikk i etologisk forskning. Forskermøte i NJF's subseksjon for pelsdyr, Kalmar, 20.-21.4.88. 18 pp.

17 Braastad, B.O., 1988. The ethological approach to reproduction problems in fox farming. In: B.D. Murphy and D.B. Hunter (Eds.), Biology, pathology and genetics of fur bearing animals. Proceedings of the IV. International Congress in Fur Animal Production, Rexdale, Ontario, August 21.-24.1988, pp. 84-94; + Abstracts pp. 8-9.

18 Braastad, B.O., 1988. Pelsdyras etologi. Kompendium, Landbruksbokhandelen, Ås-NLH. 62 pp. ISBN 82-557-0293-8.

19 Braastad, B.O., 1988. Reirkasser med tunnel kan forbedre reproduksjonen for sølvrev. Norsk Pelsdyrblad 62 (12): 12-13, 29, 1988. (and in Finsk Pälstidskrift 61 (1): 4-6, 1989; Dansk Pelsdyravl 52 (1): 58-60, 1989)

20 Jeppesen, L.L., 1988. Bange ræve får færre hvalpe. Dansk pelsdyravl, årgang 51, nr. 10, 773 - 74.

21 Jeppesen, L.L., 1988. Mere adfærdsforskning kan betale sig. Dansk Pelsdyravl, Årgang 51, nr. 3, 212.

22 Jeppesen, L.L. & Pedersen, V., 1988. Effects of visual isolation during pregnancy and lactation on reproductive succes in silver fox vixens. Scientifur, vol. 12, no. 4, November, pp. 257-260.

23 Kristensen, M.P., 1988. An evaluation of exploratory and fearmotivated behaviour as a predictor of reproductive success in silver fox vixens. Scientifur, 12: 199-205.

24 Pedersen, V., 1988. Forbedring af bur og redekassesystemer til ræv. Statens Husdyrbrugsforsøgs Årsrapport, 15pp.

25 Pedersen, V., 1988. Valgforsøg med redekasser og afføringsmønster hos rev. Norsk Pelsdyrblad, årgang 62, nr. 6, juni, p. 5.

26 Pedersen, V., 1988. Farmræven kan godt lide vinterkasse. Dansk Pelsdyravl, årg. 51, nr. 11.

27 Bakken, M., 1989. Kan sølvrevvalpers kommende morsatferd forutsies? Norsk Pelsdyrblad, 63 (10), 4-5,14.

28 Bakken, M., 1989. Early fear responses in relation to later social status and reproductive performance in silver fox cubs. Poster at 21st Int. Ethological Conference, Utrecht, 9.-17.8.89. 3 pp. (+ Abstracts, p. 9).

29 Bakken, M., 1989. Can we predict a silver fox cub's coming reproductive performance? 19th meeting of The Standing Committee of the European Convention on Protection of Animals Kept for Farming Purposes, Kollekolle (DK), 26.-27.9.89. 2 pp.

30 Bakken, M., 1989. Do social factors affect the reproduction of silver-fox vixens? Scientific Meeting on "Behaviour and housing of fur animals". Ås, 5.1.89.

31 Braastad, B.O., 1989. The effects on reproduction of providing nest boxes for silver foxes with tunnels. Scientific meeting on "Behaviour and housing of fur animals", Ås, 5.1.89. 5 pp.

32 Braastad, B.O., 1989. Comments on the draft recommendation on fur animals (dated 6.-8.12.1988) from the Standing Committee of the European Convention. 6 pp.

33 Braastad, B.O., 1989. Effects of various breeding boxes on behaviour and reproduction in silver foxes. 19th meeting of The Standing Committee of the European Convention on Protection of Animals Kept for Farming Purposes, Kollekolle (DK), 26.-27.9.89. 4 pp.

34 Braastad, B.O. and Bakken, M., 1989. Report for 1988 from the Norwegian part of the Nordic project on behaviour and housing of farm foxes. 4 pp.

35 Braastad, B.O. and Bakken, M., 1989. Nordic project: Behaviour and housing of farm foxes. Short report for the Norwegian part, March 1989. 3 pp.

36 Braastad, B.O., Hansen, I., Melkeraaen, Å. and Bakken, M., 1989. Effects of early handling on behaviour and growth in farmed silver foxes. Poster, 21st International Ethological Conference, Utrecht, 9.-17.8.1989. 3 pp. (+ Abstracts, p. 23).

37 Hansen, I. og Melkeraaen, Å., 1989. Tidlig håndtering av sølvrevvalper. Hovedoppgave, Institutt for husdyrfag, Norges landbrukshøgskole. 77 pp.

38 Harri M., Mononen J., Haapanen K and Korhonen H.1989: Thermal protection provided by year-round nest boxes for farmbred foxes and raccoon dogs. Scientifur 13(4):277-286.

39 Haapanen K, Harri M, Mononen J & Korhonen H, 1989: Lya som en termisk omgivning till fullvuxna rävar och finnsjubbar. NJFs subsektion för pälsdjur, Möte 29.9.-1.10.1989, Stockholm, Sverige. 7 sidor.

40 Jeppesen, L.L., 1989. Uændret trivsel med fast væg mellem burene. Dansk Pelsdyravl. Årgang 52, nr. 2, 83.

41 Jeppesen, L.L., 1989. On the Use of Nestboxes in Farmed Foxes. 21st International Ethological Conference, Utrecht. Abstracts p.89.

42 Jeppesen, L.L., 1989. Videnskabelig vurdering af pelsdyrs trivsel. I: Etiske aspekter i husdyrproduktionen (ISBN 8787070030). Nordisk komité for veterinærvidenskabeligt samarbejde. pp 67-74.

43 Jeppesen, L.L., 1990. Stress and Nest-boxes in Farmed Fox. Proceedings of the Society for Veterinary Ethology Summer Meeting 1990. Montecatini Terme, Pistoia, Italy.

44 Mononen J, Harri M, Haapanen K & Korhonen H, 1989: Lya som termisk omgivning till räv- och finnsjubbvalpar. NJFs subsektion för pälsdjur, Möte 29.9.-1.10.1989, Stockholm, Sverige. 5 sidor.

45 Pedersen, V., 1989. Brugen af forskellige kassetyper hos ræv. Dansk Pelsdyravlerforening's Faglige Årsberetning.

46 Pedersen, V., 1989. Effekten af tidlig håndtering på senere adfærd og stress-respons hos sølvræv. Statens Husdyrbrugsforsøg's Årsrapport, maj 1989.

47 Pedersen, V., 1989. The Effect of Early Handling on Later Behaviour and Stress-responses in the Silverfox (Vulpes Vulpes). Samt "Adfærd hos Ræv i Parringsperioden." Specialerapport til erhvervelse af naturvidenskabelig kandidatgrad, Københavns Universitet 27. januar.

48 Pedersen, V., 1989. Användning av olika lytyper för räv. Våra Pälsdjur, Svensk pelsdyrblad, årgang 60, nr. 4, April.

49 Pedersen, V., 1989. Rævehvalpene mindre bange ved tidlig menneskekontakt. Dansk Pelsdyravl, årg. 52, nr. 4.

49a Zon,A., Kubanek,D., Meller,M. 1989: Determination of optimum cage density rate of polar foxes slaughtered for skins. Scientifur, 13: 15

50 Bakken, M., 1990. Aktivitet hos sølvrevvalper, en mulig reproduksjonsindikator. Aktuelt fra Statens fagtjeneste for landbruket, nr. 4, 338-342; Norsk Pelsdyrblad, 64 (6): 6-7.

51 Bakken, M., 1990. Optimering av sølvrevproduksjonen, samspilleffekter mellom sosialt miljø og produksjon. Forskermøte i NJF's subseksjon for pelsdyr, Oslo, 2.-4.4.90.

52 Bakken, M., 1990. Sosial status som basis for testing av sølvrevvalper. NJF-seminar nr. 185, "Praktiske resultater af de seneste års nordisk pelsdyrforskning", Tåstrup (DK), 19.-21.9.90. NJF-utredning/rapport nr. 60.

52a Bakken, M., 1990. Is it possible to predict the future maternal behaviour in silver fox cubs? Scientifur, 14: 253.

53 Bakken, M., 1990. The reproduction of silver-fox vixens in relation to their own social status and the status of neigbour vixens. Abstracts, 3rd Nordic Symposium of Society for Veterinary Ethology, Sem, 1.-2.11.90.

54 Braastad, B.O., 1990. Utforming av reirkasser til sølvrevtisper. Aktuelt fra Statens fagtjeneste for landbruket, nr. 4, 333-337; Norsk Pelsdyrblad, 64 (5): 6-8.

55 Braastad, B.O., 1990. Dyrevernaspekter ved pelsdyroppdrett sett fra et etologisk utgangspunkt. Forskermøte i NJF's subseksjon for pelsdyr, Oslo, 2.-4.4.90. 6 s.

56 Braastad, B.O., 1990. Sølvrevtispers reproduksjon i reirkasser med og uten tunnel. NJF-seminar nr. 185, "Praktiske resultater af de seneste års nordisk pelsdyrforskning", Tåstrup (DK), 19.-21.9.90. NJF-utredning/rapport nr. 60.

56a Braastad, B.O., 1990. Reproduction of silver-fox vixens in nest boxes with and without entrance tunnels. Scientifur, 14: 295-296.

57 Braastad, B.O., 1990. Pelsdyras velferd sett i lys av etologisk forskning. In: S. Hedner & J.E. Trollsten (Red.), Pälsdjur och djurskydd. Svenskt Djurskyddsforum 1990, s. 46-55. Stockholm.

58 Braastad, B.O., 1990. Individual variation in maternal behaviour of silver foxes. Abstracts, 3rd Nordic Symposium of Society for Veterinary Ethology, Sem, 1.-2.11.90.

59 Braastad, B.O., 1990. Pelsdyr og dyreverndebatt. Nationen, 19.11.90, samt i Aftenposten nov. 1990.

60 Braastad, B.O. and Bakken, M., 1990. Report for 1989 from the Norwegian part of the Nordic project on behaviour and housing of farm foxes. 6 pp.

61 Hansen, I., Melkeraaen, Å., Braastad, B.O. og Bakken, M., 1990. Tidlig håndtering av sølvrevvalper. Aktuelt fra Statens fagtjeneste for landbruket, nr. 4, 362-364.

62 Harri M, Haapanen K, Mononen J, Korhonen H & Rouvinen K, 1990: Användning av liggunderlag till räv och mårdhund: faktorer som påverkar användning. NJF Seminarium nr 185, 19.-21.9.1990, Tåstrup, Danmark. 12 sidor.

63 Harri M, Mononen J, Haapanen K & Korhonen H, 1990: Kuinka lämmin on ketun pesäkoppi? Turkistalous 62(1):10-12.

64 Haapanen K, Harri M, Mononen J, Korhonen H, Niemelä P, Rouvinen K & Fors F, 1990: Lymodellens och andra miljöfaktorers inverkan på blårävens valpresultat. NJF Seminarium nr 185, 19.-21.9.1990, Tåstrup, Danmark. 5 sidor.

65 Jeppesen, L.L., 1990. Adfærdsforskning til gavn for dyrene - og for hele erhvervet. Dansk Pelsdyravl, juni 1990.

66 Jeppesen, L.L., 1990. Minken trivs fint. Rävens förhållanden forbättras. I: Hedner, S. and Trollsten, J-E (editors), Pelsdjur og djurskydd. Svensk Djurskyddsforum 1990, 38-45.

67 Jeppesen, L.L. and Pedersen, V., 1990. Improvement of management routines and cage systems in fox production. Scientifur, vol 14, no. 4, November, pp. 237-243.

68 Jeppesen L. L., og Pedersen V. 1990. Forbedring af driftsrutiner og bursystemer i ræveproduktionen. N.J.F rapport Nr. 60, N.J.F.

69 Korhonen H, Mononen J, Harri M, Mäkinen A & Alasuutari S 1990: Supikoirien tarhaus isoissa aitauksissa. Turkistalous 62(12):271-274.

70 Mononen J, Harri M, Haapanen K, Korhonen H & Stoinska M, 1990: Nest box as thermal environment for adult and newborn foxes and raccoon dogs: methods to reduce heat loss of newborn. NJF Seminarium nr 185, 19.-21.9.1990, Tåstrup, Danmark. 12 sidor. (poster abstract)

71 Pedersen, V., 1990. Det fysiske miljø's indflydelse på ræves adfærd. Statens Husdyrbrugsforsøgs årsrapport.

72 Pedersen, V., 1990. Length, growth and wearing of claws among farmed blue foxes (Alopex lagopus) with and without nest boxes. Scientifur, vol. 14, no. 2, May, pp. 101-104.

73 Pedersen, V. and Jeppesen, L.L., 1990. Effects of early handling on later behaviour and stress-responses in the silver fox (Vulpes Vulpes), Appl. anim. Behav. Sci., vol 26, July, pp. 383-393.

74 Risopatron, P., 1990. Arvegrad av fryktresponser hos sølvrevvalper. Hovedoppgave, Institutt for husdyrfag, Norges landbrukshøgskole. 59 pp.

75 Bakken, M., 1991. Infanticide hos sølvrev. NJF-seminar nr. 200. Espoo (SF), 4.-5.9.91

76 Bakken, M., 1991. Reproduksjon hos sølvrevtisper i relasjon til deres egen sosiale status og nabotispens status. Norsk Veterinærtidsskrift, 103 (2): 130.

77 Braastad, B.O., 1991. Individuell variasjon i morsatferd hos sølvrevtisper. Norsk Veterinærtidsskrift, 103 (2): 129-130.

78 Braastad, B.O., 1991. Design of nest boxes for fox females. Scientifur, 15: 49.

79 Braastad, B.O., 1991. Atferd og nærmiljø hos farmrev. Sluttrapport fra NLVF-prosjekt nr. 102.202. 6 s.

80 Braastad, B.O., 1991. Periparturient behaviour of silver-fox vixens in traditional and improved breeding boxes. In: M.C. Appleby, R.I. Horrell, J.C. Petherick and S.M. Rutter (Eds.), Applied Animal Behaviour: Past, Present and Future. Proceedings of the XXV. International Congress of Society for Veterinary Ethology, Edinburgh, 3.-6.7.1991, pp. 82-83.

81 Harri M, Mononen J, Korhonen H & Haapanen K, 1991: A study of the use of resting platforms by farmbred blue foxes. Appl.Anim. Behav. Sci. 30:125-139.

82 Harri M, Mononen J, Haapanen K & Korhonen H, 1991: Postnatal changes in hypothermic response in farmborn blue foxes and raccoon dogs. J. therm. Biol. 16(2):71-76.

83 Harri M, Cholewa R & Mononen J, 1991: Inverkan av punktvärmare på temperaturreglering och beteende hos nyfödda rävar och finnsjubbar. Nordiska Jordbruksforskares Förening, Seminarium nr 200 rörande pälsdjursproduction, 4.-6.9.1991, Esbo, Finland. 7 sidor.

84 Harri M, Mononen J & Nurminen L, 1991: Thermal protection provided by nest box for adult and newborn foxes. International Symposium "Physiological Bases for Increasing the Productivity of Predatory fur Animals". Petrozavodsk, USSR, 17.-19.9.1991:22. (abstract)

85 Harri M, Mononen J, Korhonen H & Haapanen K, 1991: Requirement for resting platforms and their use by farmbred foxes. In: AppliedAnimal Behaviour: Past, Present and Future. Proceedings of the international congress: Society for Veterinary Ethology, 25th Anniversary 1966-1991, Edinburgh, Great Britain. Universities Federation for Animal Welfare, Herts, Great Britain:148. (abstract)

86 Jeppesen, L.L and Pedersen, V., 1991. Effects of whole-year nest boxes on cortisol, circulating leucocytes, exploration and agonistic behaviour in the silver fox (Vulpes vulpes). In: Stress responses in domestic animals. Editors: K.E. Heller, L.L. Jeppesen and R. Zayan, Special issue, Behav. Processes, 25: 171-177

87 Korhonen H, Alasuutari S, Niemelä P, Harri M & Mononen J, 1991: Ketun aitaukset, pesäkopit ja hyllyt. Turkistalous 63(11):212-215.

88 Korhonen H, Alasuutari S, Niemelä P, Mononen J, Harri M & Nurminen L, 1991. Kettujen ja supikoirien pesäkopin likaisuus ja ulostamiskäyttäytyminen. Turkistalous 63(12):232-235.

89 Korhonen H, Mononen J, Harri M & Alasuutari S, 1991: Social behaviour in raccoon dogs kept in large enclosures. Scientifur 15(1):33-42.

90 Korhonen H, Alasuutari S, Niemelä P, Harri M & Mononen J, 1991: Spatial and circadian activity profiles of farmbred blue foxes housed in different-sized ground floor enclosures. Scientifur 15(3):191-200.

91 Korhonen H, Mononen J, Harri M & Alasuutari S, 1991: Latrine utilization in raccoon dogs housed in different-sized cages and enclosures. Scientifur 15(3):211-216.

92 Mononen J, Harri M, Rouvinen K & Korhonen H, 1991: Användning av liggunderlag för unga silverrävar. NJF Seminarium nr 200 rörande pälsdjursproduction, 4.-6.9.1991, Esbo, Finland. 6 sidor.

93 Mononen J, Harri M & Nurminen L, 1991: Studies of use of resting platforms by farmbred foxes and raccoon dogs. International Symposium "Physiological Bases for Increasing the Productivity of Predatory fur Animals". Petrozavodsk, USSR, 17.-19.9.1991:43. (abstract)

94 Mononen J & Harri M, 1991: Resting platform for foxes: shelter, specific need or environmental enrichment? 4th I.S.A.E. Nordic Winter Symposium, 19-21 November, Ekenäs, Sweden. (abstract)

95 Olsrød, M. og Røhme, M., 1991. Farmrevs velferd ved uttak fra bur med og uten nakketang. En objektiv og subjektiv vurdering av metodene. Hovedoppgave, Institutt for husdyrfag, Norges landbrukshøgskole. 85 pp.

96 Olsrød, M., Røhme, M. og Bakken, M., 1991. Pelsdyroppdrettemes meninger om og erfaringer med ulike håndteringsmetoder av rev. Norsk Pelsdyrblad, 65 (11), 7-12.

97 Pedersen, V., 1991. Early experience with the farm environment and effects on later behaviour in silver- (Vulpes vulpes) and blue foxes (Alopex lagopus). In: Stress responses in domestic animals. Editors: K. E. Heller, L. L. Jeppesen and R. Zayan, Special issue, Behav. Processes, 25: 163-169.

98 Pedersen, V., 1991. Effekten af selektion og tidlig håndtering på adfærden hos farmrev. Norsk Veterinærtidsskrift 103, no. 2, pp. 126-132.

99 Røhme, M., Olsrud, M. og Bakken, M., 1991. Farmrevs velferd ved uttak fra bur med og uten nakketang. En undersøkelse basert på objektive målinger av dyras atferd og hjertefrekvens ved bruk av metodene. Norsk Pelsdyrblad, 65 (9), 4-10.

100 Bakken, M., 1992. The relationship between open field activity, competition capacity and first year reproductive success among farmed silver fox cubs (Vulpes vulpes). Norw. J. Agric. Sci., Suppl. no. 9: 520-528.

101 Bakken, M., 1992. Det sosiale miljøets betydning for sølvrevtispenes reproduksjon. Faginfo fra SFFL, nr.13: 446-452; Norsk Pelsdyrblad 66 (8): 10-13.

102 Braastad, B.O., 1992. Progress in the ethology of foxes and mink. In: A. Skrede (Ed.), Progress in Fur Animal Science. Proceedings from the Vth International Scientific Congress in Fur Animal Production, Oslo, 13-16 August 1992. Norwegian J. Agric. Sci., Suppl. no. 9: 487-504.

103 Braastad, B.O. og Bakken, M., 1992. Valpebiting hos sølvrevtisper. Faginfo fra SFFL, 13: 446-451. + Norsk Pelsdyrblad 66 (5): 9-11.

104 Dale, O.K. og Bakken, M., 1992. Ein dagleg godbit skadar ikkje. Ein metode til å betre forholdet mellom rev og røkter. Norsk Pelsdyrblad, 66 (8): 13-16. Våra Pelsdjur, nr. 8, 1992.

105 Harri M, Mononen J, Rekilä T & Korhonen H, 1992: Use of resting platforms and whole year nest boxes by farmbred foxes. J. Anim. Sci. 70 (Suppl. 1): 175.

106 Harri M., Mononen J., Rekilä T. & Korhonen H. 1992. Whole year nest boxes and resting platforms for foxes. Norw. J. Agric. Sci. Suppl. 9.: 512-519.

107 Harri M. & Haapanen K. 1992: Ketun lisääntymis- ja populaatiobiologiasta (Review on red fox reproduction and population biology. In Finnish with an English summary). Luonnon Tutkija 96: 12-20.

108 Harri M., Mononen J., Cholewa R., & Korhonen H., 1992: Thermoregulation of the newborn carnivore. NJFs subsektion för pälsdjur, Forskarmötet 23-24.4.1992, Kuopio.

109 Harri M. 1992. Kuopion yliopiston uusi turkistutkimusasema vihittiin käyttöön. Turkistalous 64: 263-265.

110 Jeppesen, L.L and Pedersen, V., 1992. Correllations between levels of cortisol, behaviour and nest box use in silver fox vixens. Norwegian J. Agric. Sci., suppl. no. 9: 505-511.

111 Moe, R., Bakken, M. og Smith, A., 1992. Erfaringer med bruk av radiotelemetri i stressforskning hos rev. ISAE vintermøte, Lund (S). 8.-9.12.92.

112 Mononen J, Kohonen T, Harri M & Rekilä T, 1992: Heart rate, skin temperature and locomotor activity of farmbred blue fox. J. Anim. Sci. 70 (Suppl. 1): 171.

113 Mononen J, Harri M, Haapanen K, Korhonen H, Rouvinen K & Niemelä P, 1992: Makuuhyllyjen käyttö ketuilla/Användning av liggunderlag hos rävar. Turkistalous/-Finsk Pälstidskrift 64(3-4): 88-90.

114 Olsrød, M., Røhme, M. og Bakken, M., 1992. Stress i forbindelse med håndtering av rev. Faginfo fra SFFL, nr. 13: 469-474.

115 Pedersen, V., 1992. Effekten af forskellige håndteringsmetoder på senere adfærd hos sølvræv, Statens Husdyrbrugsforsøgs Årsmøde, 6pp.

116 Pedersen, V., 1992. Handling of silver foxes at different ages pre-weaning and post-weaning and effects on later behaviour and stress-sensitivity. Norwegian J. Agric., suppl. no. 9: 529-535.

117 Pedersen, V. and Jeppesen, L.L. 1992. Defecation paterns in the cage and in various types of whole year shelters in farmed silver foxes and blue foxes. Scientifur, Vol. 16, No. 4: 275-284.

118 Røhme, M., Olsrød, M. og Bakken, M., 1992. Alternative håndteringsmåter av rev. Faginfo fra SFFL, nr. 13: 463-468.

119 Bakken, M., 1993. The relationship between competition capacity and reproduction in farmed silver fox vixens, (Vulpes Vulpes). J. Anim. Breed. Genet. 110, 147-155.

120 Bakken, M., 1993. Reproduction in farmed silver fox vixens (Vulpes vulpes), in relation to own competition capacity and that of neighbouring vixens. J. Anim. Breed. Genet. 110: 305-311.

121 Bakken, M., 1993. Sex ratio variation and maternal investment in relation to social enviroment among farmed silver fox vixens of high competition capacity. Abstracts, XXIII International Ethological Conference, Torremolinos 3.-9.9.93, p. 162; NJF-seminar 239, NJF-rapport nr.92: 163-164.

122 Bakken, M., Moe, R. og Selle, G.M.E., 1993. Ulike antatte stressorers virkning på sølvrev. NJF-seminar 239, NJF-rapport nr.92: 32-51.

123 Bakken, M., Moe, R., and Smith, A., 1993. Man-animal relationships. NJF-seminar 239. NJF-rapport nr.92: 163-164.

124 Braastad, B.O., 1993. Periparturient behaviour of successfully reproducing farmed silver-fox vixens. Appl. Anim. Behav. Sci., 37: 125-138.

125 Braastad, B.O., 1994. Reproduction of silver-fox vixens in breeding boxes with and without an entrance tunnel. Acta Agric. Scand., Sect. A, Animal Science, 44: 38-42.

126 Braastad, B.O. and Bakken, M., 1993. Maternal infanticide and periparturient behaviour in farmed silver foxes, Vulpes vulpes. Appl. Anim. Behav. Sci., 36: 347-361.

127 Moe, R. og Bakken, M., 1993. Effekt av gjentatt blodprøve-takning på ulike immunologiske og hormonelle parametre hos sølvrev.NJF-seminar 239. NJF-rapport nr 92: 31-32.

128 Moe, R., Bakken, M. and Smith, A., 1993. Radio telemetry: A method of evaluating stress and learning ability in the silver fox (Vulpes vulpes). Abstracts, International Congress on Applied Ethology, 3rd Joint Meeting 1993, Berlin 26.-30.7.93, p. 177.

129 Bakken,M., Moe, R., Smith, A., 1993. Radio telemetry: A method of evaluating stress and learning ability in the silver fox (Vulpes vulpes). Proceedings, International Congress on Applied Ethology, 3rd Joint Meeting 1993, Berlin 26.-30.7.93. 591-594.

130 Mononen J, Rekilä, T & Harri M, 1993. Young blue foxes (Alopex lagopus) prefer resting platforms witn an unobstructed view. Int. Congr. Appl. Ethol. 26-30 July, 1993, Berlin, Germany: 161 (abstract).

131 Mononen J, Harri M, Rouvinen K & Niemelä P, 1993. The use of resting platforms by young silver foxes (Vulpes vulpes). Appl. Anim. Behav. Sci., 38: 301-310.

132 Nielsen, S.M., Pedersen, V. and Klitgård, B.B, 1993. Characteristics of Arctic fox (Alopex Lagopus) dens and den sites in the Disco Bay area, West Greenland. Arctic, in press.

133 Pedersen, V., 1991. Indhusningsforhold og driftsrutiner i ræve produktionen. Statens Husdyrbrugsforsøgs Årsrapport.

134 Pedersen, V., 1993. Effects of different post-weaning handling procedures on the later behaviour of silver foxes. Appl. Anim. Behav. Sci., vol. 37.

135 Pedersen, V., 1993. Research in housing conditions and welfare of farmed foxes. in O. Lohi and C.F. Børsting (Eds.): Research in fur animals at the National Institute of Animal Science present status and future perspectives, pp 80-85.

136 Pedersen, V., 1993. Evaluering af farmræves velfærd ud fra adfærdsmæssige og fysiologiske parametre. Manuscript til N.J.F's høstmøde, Leangkollen Norge, 23-24-september, 8pp.

137 Pedersen, V. and Jeppesen, L.L., 1993. Daytime use of various types of whole-year shelters in farmed silver foxes and blue foxes. Appl. Anim. Behav. Science, vol 36:259-273.

138 Rekilä T., Mononen J. & Harri M, 1993. The effect of environment on behaviour of farmed foxes. Int. Congr. Appl. Ethol. 26-30 July, 1993, Berlin, Germany: 128 (abstract).

139 Selle, G.M.E., 1993. Ulike antatte stressfaktorers virkning på kroppstemperatur og aktivitet hos sølvrev. Hovedoppgave, Institutt for husdyrfag, Norges landbrukshøgskole.

140 Pedersen, V., 1993. Early experience in silver foxes and effects on later behavioural and physiological parameters.Ph.D.-thesis. University of Copenhagen, November 1993.

141 Harri, M., Monoene, J. & Rekilä, T, 1994. Importance of resting platforms to farm foxes. Suomen Eläinlääkärilehti 100: 125-126.

142 Korhonen, 1994. Resting shelves for farmed blue foxes: Usage and its effect on behaviour and welfare. Suomen Eläinlääkärilehti 100: 125.

143 Mononen, J., Pyyvaara, P., Rekilä, T. & harri, M., 1994. Assessing preference for cages with and without a standard nest box in young silver foxes. (Vulpes vulpes). Suomen Eläinlääkärilehti 100: 124.

144 Rekilä, T., Mononen, J. & Harri, M., 1994. Open field behaviour and latency to eat as indicators of temperament in blu fox. Suomen Eläinlääkärilehti 100: 130. Publ.131: Appl. Anim. Behav. Sci. 38: 301-310.

Recently published papers and manuscripts in preparation

201 Bakken, M. Sex ratio variation and maternal investment in relation to social environment, among farmed silver fox vixens of high competitive capacity. J.Anim. Breed. Genet., submitted.

202 Bakken, M. Selektive og miljømessige tiltak for å redusere fryktnivået hos sølvrev. Husdyrforsøksmøtet 1994, in prep.

203 Bakken, M. 1994. Sølvrevvalpenes vekst og atferdsutvikling. Påvirkes disse indirekte som et resultat av stress overfor deres mødre under drektighetsperioden? Husdyrforsøksmøte, Faginfo., 6: 589-595.

204 Braastad, B.O. Behaviour of silver foxes in traditional and modified breeding boxes. Animal Welfare, submitted.

205 Jeppesen, L.L. Preferences for various cage facilities in silver fox and blue fox. In prep.

206 Korhonen, H. In prep.

207 Moe, R.O., Bakken, M., Haga, Ø. and Smith, A. Surgical implantation of radio transmitters in the silver fox (Vulpes vulpes) J. Zool. Wildl. Med., submitted.

208 Pedersen, V. 1994. Long term effects of different handling procedures on behavioural, physiological and production related parameters in silver foxes. Appl. Animal Behavioural Science. In press.

209 Pedersen, V. The effects of different handling procedures on later reproductive performance and behaviour in silver foxes. In prep.

210 Pedersen, V. Extra and minimal contact to humans following post weaning handling: Effects on behaviour, open field activity and cortisol levels after stress.

211 Pedersen, V. Effects of group size and density on behaviour and production parameters in farm fox. in prep.

212 Moe,R.O., Bakken,M. 1994. Vurdering av stress hos pelsdyr. Husdyrforsøksmøte, Faginfo., 6: 600-605.

213 Bakken, M. 1994. The effect of an improved man-animal relationship during pregnancy on sex ratio in litters andon growth and behaviour of cubs among farmed silver foxes (Vulpes vulpes). 28th International Congress of the ISAE. 12pp.

214 Bakken,M. 1994. Does fear of humans by silver fox affect reproductive performance and cub behaviour. Appl.Anim. Behav. Sci., submitted.

215 Bakken, M. 1994. Infanticidal behaviour and reproductive performance in relation to competition capacity among farmed silver fox vixens, Vulpes vulpes. Dr.scient avhandling 1994. Universitetet i Trondheim. ISBN-82-90896-35-2.

216 Bakken, M. 1994. Sølvrevens infanticide atferd og reproduktive evner i relasjon til deres konkurranseevne. Dr.scient foredrag. UNIT. 22pp

217 Korhonen,K., Niemelä,P. 1993. Use of resting platforms by growing blue foxes. Scientifur, 17: 271-276.

218 Korhonen,H., Niemelä,P. 1993. Talvi- ja lisääntymiskauden hyllykoe siniketuilla: tammi-heinäkuu, Turkistalous 65: 210-218.

218 Korhonen,H., Niemelä, Asikainen,J. 1994. Kasvatuskauden hyllekoe hopeaketuilla. Turkistalos 66: 76-81.

219 Pedersen,V. 1994. Forbedret miljø hos farmræve kræver kun få ændringer. Dansk Pelsdyravl, 5: 209-211.

220 Jeppesen,L.L. 1994. Velfærd hos farmræv. Problemer, men også løsninger på vej. Naturens Verden, 10: 1-8.

"Finding fossilized bones of arctic animals in the tropics indicates either climatic upheaval, continental drift or that paleolithic man had a zoo there."

Short Communication

Non-preference of adult blue foxes for platforms in multiple-choice test

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Introduction

Interest in welfare improvements for farmed fur animals has increased recently (*Jeppesen & Pedersen, 1990; Harri et al., 1991; Korhonen & Alasuutari, 1993*). This was also the main impetus for the series of platform experiments carried out for the European Convention's recommendations which presently require that each weaned fox shall have available a whole-year shelter, either a resting platform or nest box, but preferabely both (*European Convention, 1991*). Since there is no one particular generally accepted construction model for implementing the recommendation, further studies have been needed to clarify which platform types are preferred by foxes.

The present authors therefore devised a preference test system which allows the animal the possibility to seek out its preferred platform type (*Korhonen & Niemelä, 1994*). The aim of the present study was to assess the preferences of adult blue foxes (*Alopex lagopus*) for various types of platforms in such a test situation.

Materials and methods

The experiment was carried out at the Fur Farming Research Station of Kannus in western Finland between July 14 and August 19, 1993. Altogether, 10 adult male blue foxes with no previous platform experience were studied. Each fox was accustomed to the test situation one week prior to the actual testing, which was carried out during three consecutive days (2 pm-8 pm daily) by video recording the animals' behaviour in the test situation (Bische CDD video camera 7240, Koyo monitor, Bische UB-480 time lapse recorder). The preference test cage was comprised of 7 small separate cage sections (75 cm wide x 107 cm long) situated inside one large cage (52 cm wide x 525 cm long; fig. 1). This arrangement gave the test animals free access from the large cage into each of the smaller cages. The shelter constructions in the smaller cages measured from left to right as follows: (1) a nest box, measuring 70 cm long x 40 cm wide x 40 cm high, surface area 0.208 m^2, (2) a triangular, flat corner wooden platform; 65 cm x 91 cm, 0.205 cm^2, (3) a large, V-type wooden platform; 103 cm x 30 cm, 0.309 cm^2, (4) a small, V-type wooden platform; 52 cm x 30 cm, 0.156 cm^2, (5) an empty cage, with no platform or nest box, (6) a small wire mesh net platform; 52 cm x 30 cm, 0.156 cm^2, and (7) a large, wire mesh net platform; 103 cm, x 30 cm, 0.309 cm^2. Distance from the cage roof in each type was 23 cm. Platform locations were randomly chosen.

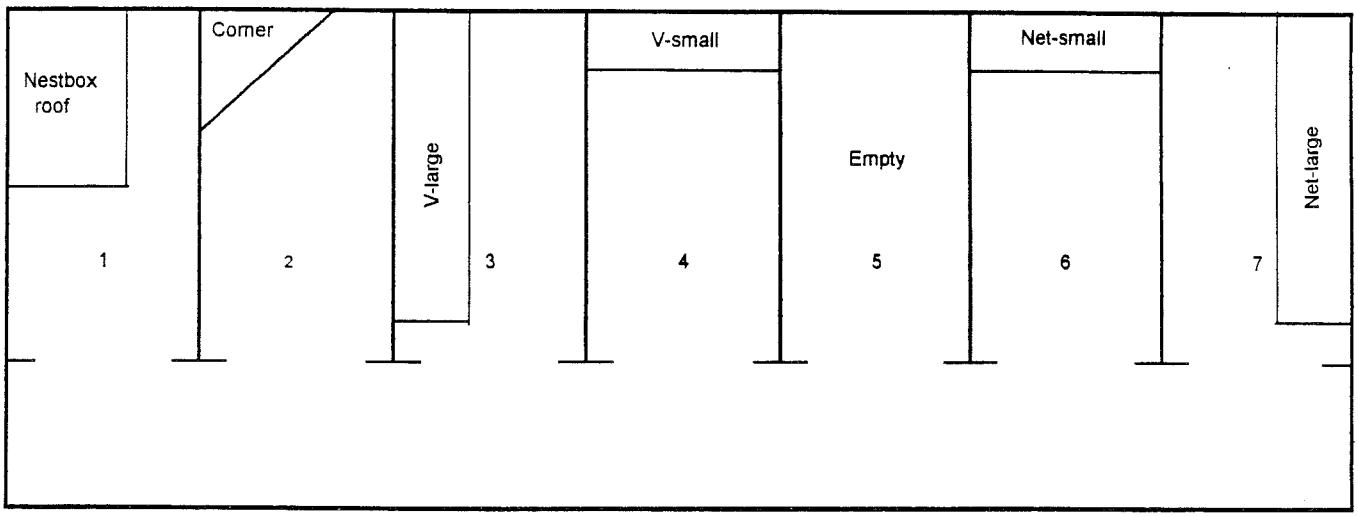

Figure 1. Schematic picture of the preferenc test system used

Results

A summary of the results is given in table 1. In general, the use of platforms was rather slight. Only three of the ten foxes tested showed more interest in some of the resting platforms provided. Mean use of all platforms, excluding the nest box was 16.8%. The highest individual use was by fox number 2, i.e. 71.1% of total time spent on platforms and, correspondingly, the lowest in fox number 9, i.e. 0.1% on platforms. Expressed as mean values, the most favored platform types were the wooden small V and large V. Although only 1-2 foxes utilized them, the frequency of use caused a high mean value.

Net platforms were used less (1.3%) than wooden ones (13.8%). Two of the test foxes spent a significant amount of time inside the nest box. Most often (74.1% of mean use) the foxes were out of the platforms or nest box on the wire mesh floor of the test cage.

Table 1 Platform and nest box use (% per 12 h) of adult male blue foxes. Data are based on video recordings. For location of platforms see fig. 1

	Nest box	Roof	Corner	V-large	V-small	Empty	Net-small	Net-large
Fox 1	1.1	1.1	0.1	0.1	29.3	0.3	0	0
Fox 2	0.6	0.7	0	57.5	2.8	0.1	0.2	10.5
Fox 3	0.4	0.5	2.4	7.8	40.5	0.5	2.0	0.3
Fox 4	0.7	0	0	0	0	0.5	0	0
Fox 5	0.2	0.4	0	0	0	0.7	0	0
Fox 6	1.4	0	0	0	0	1.2	0	0
Fox 7	30.4	0	0	0	0	0.1	0	0
Fox 8	0	0	0	0	0	0.8	0	0
Fox 9	56.4	0	0	0	0	0.1	0	0
Fox 10	0	0	0	0	0	6.8	0	0
Mean	9.1	0.3	0.3	6.5	7.3	1.1	0.2	1.1

Discussion

The results of the present preference tests support the conclusion of previous experiments (*Harri et al., 1991; Korhonen & Niemelä, 1993, 1994*) that the majority of farmed blue foxes only use platforms occasionally and to a rather limited extent. However, there are also some foxes which, for one reason or another, prefer platforms. Such large individual differences make a final conclusion somewhat difficult: should the needs of foxes that use platforms somehow be taken into consideration or would it be better to omit platforms altogether. At least for farmers it is, of course, very difficult to identify individual foxes likely to use platforms as this would require intensive observations on their part.

Platforms and nest boxes can be considered as environmental enrichments, which provide foxes with the possibility for variable behaviours along with increasing stimuli. In silver foxes, there is some evidence that animals having had access to such enrichments in whole-year shelters have had a lower level of stress and fear than animals without access (*Jeppesen & Pedersen, 1991*). Nevertheless, the very low amount of platform use found in the present and in several previous studies raises the question as to whether or not platforms really bring about any welfare improvements or otherwise promote animal well-being. Further studies will be needed to clarify this more precisely.

Experiments during the growing season (*Korhonen & Niemelä, 1993*) have revealed that foxes most often used the platform type V. The present results yielded some additional evidence to that direction also. Actually, however, it is difficult to recommend any of the platform types studied on account of their generally low preference in comparison with their preference for the cage floor.

References

European Convention 1991. European Convention for the protection of animals kept for farming purposes. Strasbourg 1976, ETS 87. Recommendation Concerning fur Animals, 25 June 1991, 19 pp.

Harri, M., Mononen, J., Korhonen, H. & Haapanen, K. 1991. A study of the use of resting platforms by farmbred blue foxes. Appl. Anim. behav. Sci. 30: 125-139.

Jeppesen, L.L. & Pedersen, V. 1990. Improvement of management routines and cage systems in fox production. Scientifur 14: 237-242.

Jeppesen, L.L. & Pedersen, V. 1991. Effects of whole-year nest boxes on cortisol, circulating leucocytes, exploration and agonistic behaviour in the silver foxes (*vulpes vulpes*). Behav. proces. 25: 171-177.

Korhonen, H. & Alasuutari, S. 1993. Preference behaviour of raccoon dogs in a cage-enclosure housing system. Scientifur 17: 277-279.

Korhonen, H. & Niemelä, P. 1993. Use of resting platforms by growing blue foxes. Scientifur 17: 271-276.

Korhonen, H. % Niemelä, P. 1994. Preferences of farmed blue foxes for platforms, nest box and cage floor. Agric. Sci. Finl. (In press).

Infanticidal Behaviour and Reproductive Performance in Relation to Competition Capacity among Farmed Silver Fox Vixens, *Vulpes vulpes*

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New doctor in the family. We congratulate Morten bakken with the new title and wish him success in the future.

The aim of the thesis:

The aim of the thesis is, through ethological studies, to reach a deeper understanding of the reproductive behaviour of farmed silver fox females as a basis for developing methods to reduce the frequency of infanticidal silver fox vixens and increase the number of cubs weaned among farmed silver fox vixens. This is of importance both from an animal welfare point of view and from the economic standpoint of the farmer. The main problem studied concerns; 1) the behaviour of infanticidad vixens during parturition, 2) relationship between the vixens competition capacity and their reproductive performance, both in relation to number of cubs weaned and in relation to sex ratio in the litter, and 3) the predictability of a young vixens future reproductive performance from knowledge about her early fear reaction and competitive capacity.

Variation in reproductive output or loss of cubs not correlated to social factors will be assumed to be randomly distributed among the different groups of vixens in the presented experiments. The thesis includes four published papers and one submitted to Journal of Animal Breeding and Genetics:

I) Braastad, B.O. and Bakken, M. 1993. Maternal infanticide and periparturient behaviour in farmed silver foxes *Vulpes vulpes*. *Appl. Anim. Behav. Sci.*, 36, 347-361. **Abstracted in SCIENTIFUR, Vol. 18, No. 2, pp 117, 1994.**

II) Bakken, M. 1993. The relationship between competition capacity and reproduction in farmed silver-fox vixens, *Vulpes vulpes*. *J. Anim. Breed. Genet.*, 110, 147-155. **Abstracted in this issue of SCIENTIFUR.**

III) Bakken, M. 1992. The relationship between open field activity, competition capacity and first year reproductive success among silver fox cubs (*Vulpes vulpes*). *Norw. J. Agric. Sci.*, Suppl., 9, 520-528. **Abstracted in SCIENTIFUR, Vol. 16, No. 4, pp 327, 1992.**

IV) Bakken, M. 1993. Reproduction in farmed silver fox vixens, *Vulpes vulpes*, in relation to own competition capacity and that of neighbouring vixens. *J. Anim. Breed. Genet.*, 110, 305-311. **Abstracted in this issue of SCIENTIFUR.**

V) Bakken, M. Sex ratio variation and maternal investment in relation to social environment among farmed silver fox vixens, *Vulpes vulpes*, of high competition capacity. *J. Anim. Breed. Genet.*, submitted. **Abstracted in this issue of SCIENTIFUR.**

Dr. scient, Thesis, 1994. Zoological Institute, University of Trondheim, Norway. ISBN-82-90896-35-2. In ENGL, 36 pp. 1 table, 1 fig, 65 refs.

Paper II:

From the outset, poor reproduction in some of the vixens has been a problem in silver-fox farming. Some vixens fail to bear cubs and others kill their cubs just after delivery. To get a better understanding of reproductive behaviour

in farmed silver fox vixens, their behaviour was compared with earlier observations made on groups of wild-living red foxes (*Vulpes vulpes*).

The results indicated similarities in the reproductive behaviour of farmed silver foxes and group-living wild red foxes. Thus vixens that weaned most of their cubs unharmed, under standard farming conditions, had a higher competition capacity than vixens that did not wean cubs. Moreover, the vixens' competition capacity was a better reproductive indicator than age among related vixens (mother and her primiparous daughter). Furthermore, vixens that had previously been infanticidal, under standard farming conditions, weaned more cubs unharmed the next reproductive season, when isolated from the other vixens in the farm. The paper also describes a case description in which an infanticidal vixen adopted a cub from another vixen one hour after she had killed and eaten her own cub.

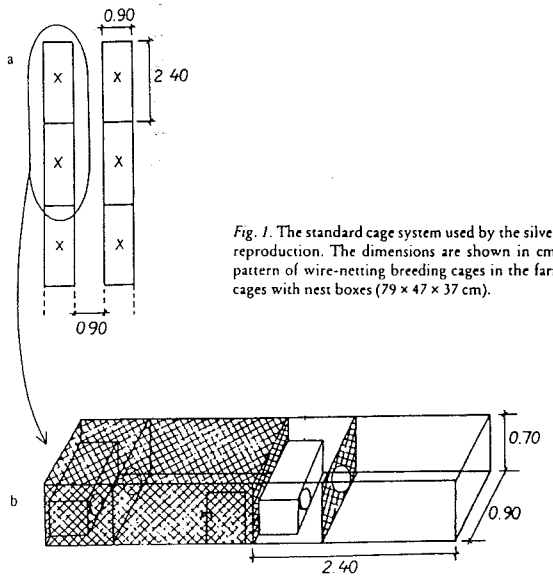


Fig. 1. The standard cage system used by the silver fox females during reproduction. The dimensions are shown in cm. a) The placement pattern of wire-netting breeding cages in the farm. b) Two breeding cages with nest boxes (79 × 47 × 37 cm).

In ENGL, Su. ENGL, GERM. 3 figs., 21 refs. Author's summary.

Paper IV:
Reproductive performance in 34 one-year old and 5 two-year old farmed silver fox vixens was recorded and related to their competition capacity and that of neighbouring vixens. The vixens were tested for competition capacity at 5-7 months of age, and divided into high (HCC), medium (MCC) and low (LCC), according to their competition capacity score. After selection, they were placed together with neighbours as follows; HCC with LCC or HCC neighbours, MCC with MCC neighbours and LCC vixens with LCC, MCC, or HCC neighbours. The vixens had the same neighbours from October to the end of the reproductive season in June/July the following year and were separated from their neighbours by double wire netting only.

Only small differences were found between the experimental groups in the number of cubs born. The HCC vixens with LCC neighbours weaned more cubs than any of the other vixens, including HCC vixens with other HCC vixens as neighbours. No LCC vixen weaned cubs unharmed if her neighbours were of higher competition capacity, but did so with other LCC vixens as neighbours. The study indicated that social factors significantly influence maternal behaviour in farmed silver foxes.

In ENGL, Su. ENGL, GERM. 2 tables, 1 fig., 25 refs. Author's summary.

Paper V:
The sex ratio and body weights of offspring from 13 non-infanticidal farmed silver fox vixens of high competition capacity (HCC), reared under two different neighbouring conditions, were measured. Seven vixens had other HCC vixens as neighbours, whereas the other group had neighbouring vixens of low competition capacity (LCC). The vixens with LCC neighbours gave birth to and weaned more cubs, with a significantly higher proportion of males (73%), and female cubs of a relatively better quality at thirty days of age (female cubs on average 11 g heavier than their brothers) than the vixens with HCC neighbours (31%♂, female cubs on average 79 g lighter than their brothers). This study indicates sex-ratio regulation in relation to social environment among farmed silver fox vixens of high competition capacity. The results are discussed in relation to behaviour and reproductive consequences for the female cubs and in relation to ultimate and proximate theories.

In ENGL. 1 table, 1 fig., 38 refs. Author's summary.

Estimating body fat by using bioelectrical-impedance measurements: A preliminary assessment

Martin G. Raphael, Henry J. Harlow, Steven W. Buskirk

We evaluated a technique for measuring body fat content of marten (*Martes americana*) by using a noninvasive bioelectrical-impedance device with four electrodes to introduce a current into the body. Instantaneous readings of resistance were significantly correlated with fat-free mass (determined from solvent extraction) of carcasses of 17 skinned ($r = 0.83$, $P = 0.01$) and 6 intact ($r = 0.89$, $P = 0.03$) marten. Estimates of percentage of body fat were not accurate among skinned animals but were accurate among unskinned animals. With further refinement, this technique may be useful because the device is noninjurious, easily used, quick, and portable.

United States Department of Agriculture, Forest Service, Pacific Northwest Research Station. General technical report PNW, GTR-279. 4 tables, 10 refs. Authors' abstract.

Social relationships and reproductive performance in group-living arctic blue foxes

Hannu Korhonen, Sakari Alasuutari

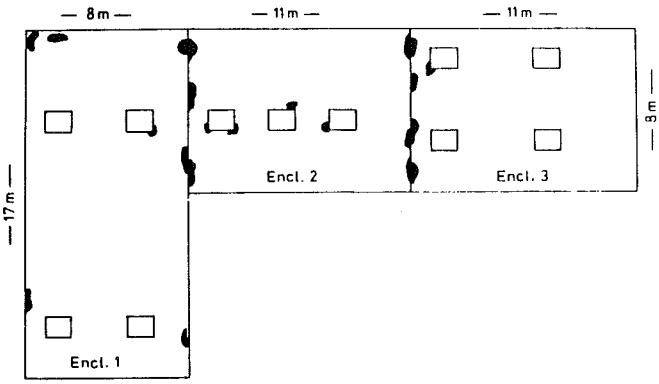


Fig. 1. Schematic picture of the experimental enclosures. Dark dots represent the sites of urine markings.

The aim of the present work was to study social relationships and reproductivity in captive arctic blue fox groups of different genetic origin. The social status of the individuals among groups remained constant during autumn and early winter. Males typically dominated over females in the groups. Males also had higher body weights and more social contacts than females. The locomotor activity of the animals increased during the breeding season, especially in the case of males. Urinary marking had significant importance during the breeding season, being most pronounced in dominant males. No synchronization was observed in the heat development of females despite some kinship. Behaviours such as escape attempts, bitings and increased aggressiveness occurred in March-April as a result of increasing social tension combined with reproductive behaviour. Whelping success

varied depending on group composition. Some of the non-breeding and breeding females were observed to act as communal nursing helpers.

Agricultural Science in Finland 3, pp 49-58. 5 tables, 1 fig., 21 refs. Authors' summary.

Isotype-specific rabbit antibodies against chinchilla immunoglobulins G, M, and A

Sheri Konietzko, Markku Koskela, Gary Erdmann, G. Scott Giebink

Chinchillas have become a preferred animal model for studying otitis media, and are also useful in studying insulin release, gastrin physiology, intestinal infection, and hepatocellular pathophysiology. Immunopathologic studies in the model, however, have been limited by absence of specific antibody reagents against chinchilla immunoglobulins. We describe a method for preparing isotype-specific rabbit antibodies against the heavy-chain components of chinchilla immunoglobulins G, M, and A. Chromatographic techniques were used to isolate chinchilla immunoglobulins from serum and breast milk; heavy-chain fractions were isolated and used as antigens to produce isotype-specific antibodies in New Zealand White rabbits. Enzyme-linked immunosorbent assay of these antisera disclosed anti-light chain cross-reactivity, which was removed by affinity chromatography. The isolation and affinity purification techniques were highly reproducible. The availability of these reagents should greatly enhance the utility of the chinchilla in modeling human disease.

Laboratory Animal Science, Vol. 42, No. 3, pp 302-305. 1 table, 5 figs., 13 refs. Authors' abstract.

A bibliography of mustelids: Part IX: European mink

Philip M. Youngman

This is the ninth of a series of bibliographies on mustelids. Previous parts were published by Michigan State University under the editorship of Richard J. Aulerich. This list of publications is limited to the literature on the European Mink, *Mustela lutreola* (Linnaeus, 1761) from 1549 to the present (cut-off date 31 October 1990). I have included the bulk of the literature on this species, however a relatively large number of early publications have been impossible to obtain for verification though they are included.

The criterion for inclusion is that a publication, or thesis, mentioned the European Mink, no matter what the context. Most of the incomplete citations in the Russian language are from Novikov, 1939. A number of references were not seen by me: a number are incomplete. It would be appreciated if readers noting omissions and errors would send me new or corrected citations (preferably typed), and new papers as they are published. I will attempt to make revisions available on disk, or print-out, on request.

References are listed alphabetically by senior author. Titles of publications transliterated from the cyrillic alphabet are enclosed in brackets.

This bibliography is being published with the hope that it may assist studies of this interesting, rare and endangered carnivore.

For comments, corrections and additions, I am grateful to Drs. I. Héran, D. Miric, D. Murariu, O. Rossolimo, A.L. Ruprecht, N. Spassov, M. Stubbe, and Michel Tranier. The cover design by V.M. Smirian is from Ternovskii, 1975. I thank Gail Rice and Joanne Dinn for typing the manuscript.

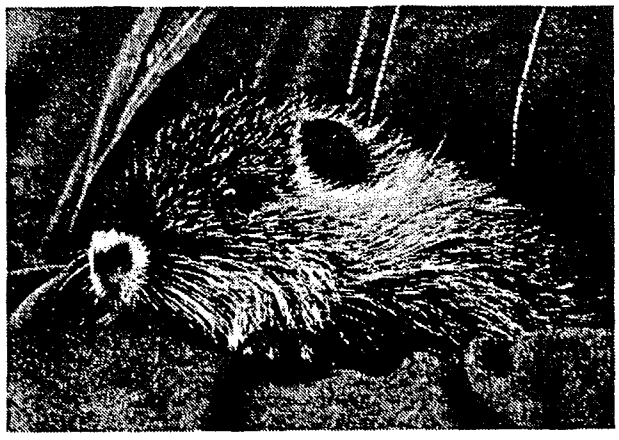
Syllogeus, no. 66, pp 45, 1991. Author's introduction.

The intensity of growth in coloured strains of nutrias

A. Truxa

For standard, silver, greenland and black male nutrias (numbers are not given), birth weight averaged 220, 245, 190 and 225 g resp. in summer and 230, 155, 195 and 220 g in winter; body weight at 3 months of age averaged 2130, 1690, 1800 and 2000 g for those born in summer and 1920, 1680, 1170 and 1650 g for those born in winter, and body weight at 7 months 5050, 4680, 4690 and 5060 g for those born in summer, and 4550, 4450, 3550 and 4800 g for those born in winter. The corresponding figures for females were 230, 260, 165 and 220 g for those born in summer and 220, 150, 170 and 215 g for those

born in winter, 1950, 1470, 1430 and 2110 g for those born in summer and 1470, 1490, 1290 and 1450 g for those born in winter, and 4520, 3290, 3840 and 5020 g for those born in summer and 3800, 3630, 3000 and 3450 g for those born in winter.



Chovatel 29, 4, pp 10-11, 1990. 2 tables. In CZECH. CAB-abstract.

Phylogeny and classification of early European *Mustelida (Mammalia: Carnivora)*

Mieczyslaw Wolsan

A phylogenetic analysis of the Oligocene and some Neogene European arctoid carnivores of the order-group taxon *Mustelida* is performed, based on characters of the skull and dentition. The following classification of the revised genera is proposed: *Simocyon (Aliurus, Amphictis, Bavarictis, Potamotherium (Pseudobassaris (Angustictis* gen. n., *Broiliana)) (Mustelictis ((Franconictis* gen. n., *Stromeriella) (Bathygale* gen. n., *(Plesictis (Paragale, Plesiogale)))))). Potamotherium* is allied to phocids within the monophyletic *Pinnipedia. Pseudobassaris, Angustictis* gen. n., and *Broiliana* are considered procyonids. *Mustelictis, Franconictis* gen. n., *Stromeriella, Bathygale* gen. n., *Plesictis,* and the mustelines *Paragale* and *Plesiogale* are placed in the *Mustelidae. Parailurus* is included in *Ailurus*, and *Ichneugale (= Viretius, = Alopecocyon)* is synonymized with *Amphictis.* Phylogenetic definitions and diagnoses are provided for the suprageneric taxa: *Carnivora, Caniformia, Arctoidea, Arctomorpha* (new), *Mustelida, Pinnipedia, Procyonida, Mustelidae,* and *Mustelinae.*

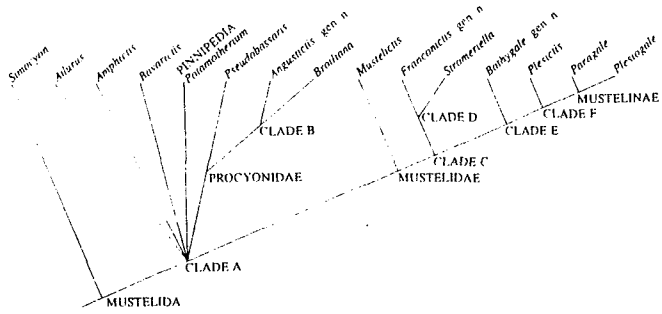


Fig. 7. Hypothesis of the phylogenetic relationships among the early European mustelidans based on an analysis of craniodental characters. *Ailurus, Amphictic, Bavarictis, Pinnipedia, Procyonidae,*and *Mustelidae* are interpreted as having originated independently from a common ancestral group within Clade A because no unique synapomorphy could be identified to give secure grounds for a hypothesis concerning interrelationships among these taxa.

Acta Theriologica 38 (4), pp 345-384, 1993. 1 table, 7 figs., 121 refs. Author's abstract.

Foraging by lynx and its role in ungulate mortality: the local (Bialowieza forest) and the Palaearctic viewpoints

Wlodzimierz Jedrzejewski, Krzysztof Schmidt, Lech Milkowksi, Bogumila Jedrzejewska, Henryk Okarma

Lynx *Lynx lynx* (Linnaeus, 1758) - ungulate relationships were studied in the exploited (530 km^2) and pristine (47.5 km^2) parts of Bialowieza Primeval Forest during 1985 through 1992. In pristine forest, *Sus scrofa* (54%) and *Cervus elaphus* (36%) and *Capreolus capreolus* (33%) were most abundant. Scat analysis indicated that cervids comprised 87% of biomass consumed by lynxes in the cold season; *Lepus europaeus* were 11%, and *S. scrofa* 2%. Hare was 2.5 times higher in the lynx diet in the exploited forest than in the pristine forest. Among 138 carcasses of ungulates killed by lynx in exploited forests in cold seasons, 76% were roe deer. In the pristine forest, red deer (61%) and roe deer (28%) were equally positively selected. Lynx did not select roe deer for any sex/age class but did select red

deer fawns. Snowtracking showed that lynx attempted 1 attack on deer, 2 on medium-sized prey, and 6 on rodents in their daily route. Lynx fed an average of 3-4 days on a killed deer. Eight species of scavengers (mainly wild boar and red fox) fed on lynx's kills. Analysis of 1090 ungulate carcasses found in Bialowieza Forest showed that predation was responsible for 75% of known natural mortality in red deer (66% by wolf *Canis lupus* Linnaeus, 1758; 9% by lynx), 62% in roe deer (37% by lynx, 25% by wolf), 27% in moose (all by wolf), and 12% in wild boar (11% by wolf, 1% by lynx). Review of studies from the Palaearctic region revealed that the share of hare in lynx diet positively correlated with latitude, whereas the share of ungulates was inversely related to latitude. From palaearctic ungulates that ranged from 15 kg body mass (*Moschus moschiferus*) to 920 kg (male *Bison bonasus*), the lynx selected the smallest species available. Means electivity index (D) for 9 ungulate species was negatively correlated with their log body mass. In the Palaearctic region, predation contributed, on average, 1% to the natural mortality of European bison, 25% to that of wild boar, 59% of moose, 80% of red deer, and 85% of roe deer. Of total predation-caused mortality, the average share caused by lynx was 46% in roe deer, 14% in red deer and little or none in wild boar, moose, and bison.

Acta Theriologica 38 (4), pp 385-403, 1993. 7 tables, 3 figs., 65 refs. Authors' summary.

Foraging by pine marten *Martes martes* in relation to food resources in Bialowieza National Park, Poland

Wlodzimierz Jedrzejewski, Andrzej Zalewski, Bogumila Jedrzejewska

Feeding habits of pine marten *Martes martes* (Linnaeus, 1758) were studied in 1985-1992 in the pristine forests of Bialowieza National Park, eastern Poland. The study covered 5 years of moderate numbers of forest rodents and 2 years of increase and decline. In 1735 analysed scats, rodents (*Clethrionomys glareolus, Apodemus flavicollis*, and *Microtus* sp.) were staple food for martens, constituting from 50% of biomass consumed in June to over 90% in October-November. Birds (mainly thrush and woodpeckers) were captured by martens mainly in spring and summer (up to 37% biomass in June). Vegetable matter (*rubus* berries, *Sorbus aucuparia* fruit, mushrooms) was frequently eaten in July-October (up to 17% biomass in September). Ungulate carcasses were scavenged in winter. Marten preferred the remains of wolf and lynx kills and avoided ungulates that had died from undernutrition and/or disease. Between-year variation in marten diet was determined by variation in rodent (especially bank vole) numbers. Percent of bank vole biomass in marten diet in autumn-winter was determined by the summer-autumn numbers of these rodents. Martens' consumption of mice in the cold season did not reflect the changes in mouse numbers, but it was positively correlated with their preying on bank voles. Spring numbers of mice determined the percentage of biomass of mice in marten diet in spring-summer. Snow cover significantly decreased martens' preying on *C. glareolus*, but not *A. flavicollis* and *Microtus* sp. In the cold season, insectivores and ungulate carcasses were crucial alternative food for the pine marten and they compensated for the decreased availability of rodents. In spring and summer, birds and fruit were alternative food, the consumption of which negatively correlated with the consumption of rodents. Snow-tracking showed that in their search for prey, martens utilized both fallen and standing trees, and moved on the ground as well as in the forest canopy. Over 90% of all recorded attacks were on rodents. Marten attacked rodents 4.1 times/km of trail but 35% of attacks failed.

Acta Theriologica 38 (4), pp 405-426, 1993. 7 tables, 8 figs., 63 refs. Authors' summary.

Home range and activity patterns of red fox *Vulpes vulpes* breeding females

Alejandro Travaini, Juán J. Aldama, Rafael Laffitte, Miguel Delibes

Home range size and activity pattern were evaluated by radiotracking of seven red fox *Vulpes vulpes* (Linnaeus, 1758) breeding females, in the Donana Biological Reserve, SW Spain. Mean home range size was 218 ha (SD = 76, $n = 7$). A home range for one of the seven females was 1129 ha for one nearly complete year and only 253 ha for the same female during the breeding season. We suggest that this size reduction could be a result of energetical and behavioral shifts due to the breeding condition. Activity was

slightly increased during nights with long resting periods during light hours. Total mean travelling distances was 6686 m in 24-hour cycles. Daytime and nighttime mean distance covered were 2101 and 4585 m, respectively.

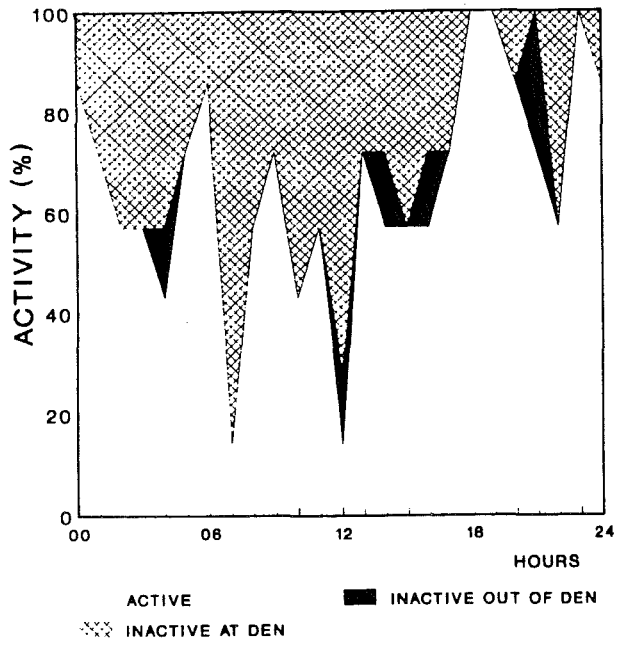


Fig. 3. Percent of active and inactive time estimated from intensive 24-h radiotracking periods. Two possible inactive situations were considered: inactive at the den and inactive at any other place

Acta Theriologica 38 (4), pp 427-434, 1993. 2 tables, 3 figs., 29 refs. Authors' summary.

The use of the principal components method for the phenotypic analysis of an integral domestication trait

L.L. Vasileva, L.N. Trut

In the course of long-term experiment on domesticaion of silver fox, it was necessary to determine the most important behavioral features, selection for which would give domestication effect. The mathematical method of principal components was used for the analysis of 20 fox behaviour traits. The combination of the initial traits which reflected the structure of the integral trait, i.e. domesticated type of behaviour, was determined. The practical use of this combination seems to more adequately estimate the level of domestication of a given animal, which is indispensable for subsequent effective selection.

Genetika, 26, No. 2, pp 516-524, 1990. 2 tables, 3 figs., 23 refs. In RUSS, Su. ENGL. Authors' abstract.

Size of nutria versus some indices of fur coat value

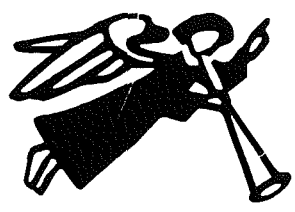
Ryszard Cholewa

Investigations were carried out on a total of 79 Greenland nutria in Höfer farm belonging to the Institute of Small Animals in Celle (Germany). Their aim was to study the effect of body weight on the pelt traits in the even-aged nutria.

The graded animals at 210 days were weighed and slaughtered. Their pelts were estimated organoleptically, weighed and their lengths were measured. Laboratory measurements concerned fur coat: colour lightness, SGM, percentage of underhair, height and diameter of hair and the medulla of hair in both layers.

It was found that with an increasing live weight there was a significant increase in the length and weight of pelts as well as in SGM measurement in males, whereas in females an increase in the sum of exterior traits and height of guard hair.

Biuletyn Informacyjny Instytutu Zootechniki (Poland), v. 28 (5-6), pp 97-102, 1990. 2 tables, 4 refs. Author's summary.



Original Report

Electrophysiologic and morphologic assessment of genetic deafness in the Hedlund white mink (Mustela vison)

S.M. Stejskal[*], *J.A. Render*[**], *R. Altschuler*[***], *R.J. Aulerich*[*]

Departments of Animal Science[*] *and Pathology*[**],

Michigan State University, East Lansing, MI

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University of Michigan, Ann Arbor, MI

Abstract

Auditory brainstem responses and histologic examination of the inner ear were used to assess development of the auditory system in genetically deaf Hedlund white mink. Findings were compared to those of standard dark mink with normal hearing. Auditory brainstem responses were evident by 26 days of age in standard dark mink and persisted throughout the testing period of 18 months. Auditory brainstem responses were elicited in Hedlund white mink from 34 to 46 days of age, but were not evident at 55 days of age. Prior to the loss of auditory brainstem responses, there was persistence of the first response wave in some kits suggesting that cochlear function existed, even though histologic lesions were present in the cochlea. Cochlear lesions which were noted in the basal turns, included thinning of the stria vascularis, collapse of Reissner's membrane, rolling up of the tectorial membrane and loss of neurons in the spiral ganglion.

Introduction

Hedlund white mink (HWM) have been described as being deaf because they fail to respond to acoustic stimuli (*Flottorp and Foss, 1979*). Results of behavioural observations and histologic examination indicate that auditory lesions in the HWM are very similar to those pigment-associated hereditary auditory lesions found in Dalmatian dogs, blue-eyed white cats and human beings (*Saunders, 1965; Anderson et al., 1968; Mair and Laukli, 1987; Powell and Zielinski, 1989, Gerwitz, 1991*). Using histologic and electrophysiologic procedures, the chronological development of the auditory system of HWM was compared with that of standard dark mink (SDM) to determine the potential of HWM as an animal model for hearing research.

Materials and methods

Seven Hedlund white mink (HWM) kits between 26 and 55 days of age from three different lit-

ters were tested for auditory brainstem responses (ABR) at two day intervals. ABRs were performed at most of the recording timepoints on at least two additional HWM kits of the same age. Those kits were then immediately euthanized and chochleas collected for histological examination. Three 180-day-old HWM were euthanized and their cochleas examined. Two SDM kits were tested for brainstem responses at four timepoints between 26 and 41 days of age. ABRs were conducted on eight (two 41-day-old and six, seven to 18-month-old) SDM to establish a baseline for wave latencies. Five SDM between the ages of six weeks and eight months were euthanized and their cochleas examined histologically.

The kits used in the study were raised at the Michigan State University Experimental Fur Farm. Adult SDM from the Fur Farm were used as breeding stock and were considered "normal" based on their behavioral response to acoustic stimuli. HWM breeders were purchased from a commercial mink farm. None of the adult HWM mink were closely related or demonstrated any behavioral response to sound. All the adult mink were individually housed in wire cages with attached nest boxes in open-sided buildings and were exposed to ambient temperature, humidity and photoperiod. The nest boxes were filled with excelsior (wood wool) during the winter and whelping period. Feed and drinking water were provied *ad libitum*. The mink were raised according to commercial mink husbandry practices and their use and care was approved by the Michigan State University All University Committee on Animal Use and Care.

The females were bred in February and March and care was taken to avoid inbreeding or line breeding. Most of the kits were whelped in early May, weaned at about eight weeks of age, and then housed in pairs. The ability to hear, based on behavioral response, was assessed daily during routine care of the animals. Normal environmental sounds elicited an immediate response from the SDM, but the HWM showed no Preyer's or startle responses at any time.

The ability of SDM and HWM to hear was evaluated on a Bio-Logic Brain Atlas II evoked potential unit (Mundelein, IL). All kits were anesthetized by an intraperitoneal injection of acepromazine (0.055 mg/kg), atropine (0.11 mg/kg), ketamine (33 mg/kg) and xylazine (2.2 mg/kg). This provided anesthesia for about 30 to 45 minutes. Four platinum subdermal needle electrodes (Grass Laboratories; Madison, WI) were placed on the left and right mastoid (reference leads), vertex (active lead) and the subcutaneous region between the eyes (ground). Potentials were recorded by stimulating the left ear via insert earphones. White noise masking was used in the right ear at levels 15 dB (decibels) less than the acoustic stimuli. The stimulus parameters used to record ABRs were patterned after those established by the American Electroencephalographic Society and included monaural testing of the left ear; broadband click stimulus with alternating phase contrast; 10 msec window; rate of 10.1 stimuli per second and 520 to 1040 non-rejected sweeps (*Anon. 1986; Kelly et al., 1989*).

Because the pattern of the waveform is highly reproducible, the latencies (in msec) of waves 1, 3 and 5 were measured in both the SDM and HWM. As the 90 dB HL (hearing level) was the highest intensity available on the recorder and, as it was often the only level which would evoke a response in the HWM kits, ABRs collected at that intensity in the HWM and SDM were compared. The latencies of the ABR waves were considered abnormal if they were more than two standard deviations from the mean of the control SDM.

For histologic examination of the cochleas, the kits were anesthetized and perfused systemically with isotonic saline followed by 10% neutral buffered formalin. The cochleas were removed, the perilymphatic space was perfused with 2% glutaraldehyde and then post-fixed in 1% osmium tetroxide in 0.1 M phosphate buffer for one hour at 4 C. They were rinsed several times in 0.1 M phosphate buffer and then decalcified for several weeks in 4% ethylenediamine tetraacetate (EDTA) in water until the cochleas were palpably soft. They were embedded in resin (Embed-12; Ted Pella, Inc.; Redding, CA) and sectioned. Mid-modiolar (1 um thick) sections were stained with 1% toluidine blue and the basal turns were examined with a light microscope.

Results

ABRs were not detected in HWM kits less than 34 days of age (table 1). A wave 1 response was detected in four HWM kits on day 34, but the

wave 1 latencies were much longer than those deteced in 34-day-old SDM kits. Wave 1 was detected at 36 days of age in only two HWM kits. On day 38, all five waves were again recorded in one animal, while four other kits demonstrated only wave 1. At day 42, three HWM had complete ABRs, although the wave 1 and 3 latencies were much longer in comparison to the 41-day-old SDM. The wave 5 latencies in those HWM were similar to latencies in their SDM counter parts. By 46 days of age, only one HWM kit had a five wave response. By 55 days of age, none of the HWM kits showed a behavioral response to sound or had an ABR, so they were presumed deaf.

Histological lesions were present in the basal turn of cochleas of HWM as early as 30 days of age. There was partial collapse of Reisner's membrane, but with time, the lesions became more severe and were characterized by the complete collapse of Reissner's membrane and curling and retraction of the tectorial membrane into the inner spiral sulcus (Fig. 1). Thinning of the stria vascularis was apparent in 30-day-old HWM. Atrophy of the stria vascularis was evident at 180 days, when contrasted with a comparably aged SDM (Fig. 2). By 180 days, neurons in the spiral ganglion of HWM appeared less numerous and less dense when compared to the neurons in the spiral ganglion of similarly aged SDM (Fig. 3).

Table 1 Mean latencies (in msec) of auditory brainstem responses (ABR) in standard dark mink (SDM) and seven Hedlund white mink (HWM) over time

Age (days)	Wave 1[a]	Mean	SD	Wave 3[a]	Mean	SD	Wave 5[a]	Mean	SD
HWM									
26	0			0			0		
30	0			0			0		
32	0			0			0		
34	4	2.34[b]	0.5	0			0		
36	2	1.75[b]	0.07	0			0		
38	5	1.79[b]	0.66	1	3.68[b]		1	4.72[b]	
40	3	1.41[b]	0.12	3	3.50[b]	0.05	3	5.13	0.7
42[c]	4	1.47[b]	0.56	3	3.18[b]	0.20	3	5.11	0.7
44	2	1.20[b]	0.20	2	3.31[b]	0.29	2	4.99	0.58
46	2	1.81[b]	0.71	1	3.92[b]		1	5.40	
55	0			0			0		
SDM									
26	2	1.03	0.02	2	2.87	0.72	2	5.07	0.02
34	2	0.97	0.04	2	2.72	0.57	2	4.50	0.23
38	1	0.94		1	3.34		1	4.36	
41	2	0.96	0.03	2	2.86	0.23	2	5.14	0.11
>41	8	0.93	0.17	8	2.53	0.28	8	4.62	0.50

[a] The number of animals having ABR
[b] Latency greater than two standard deviations from control latencies
[c] HWM showing no ABR for two successive timepoints were not tested after 42 days of age

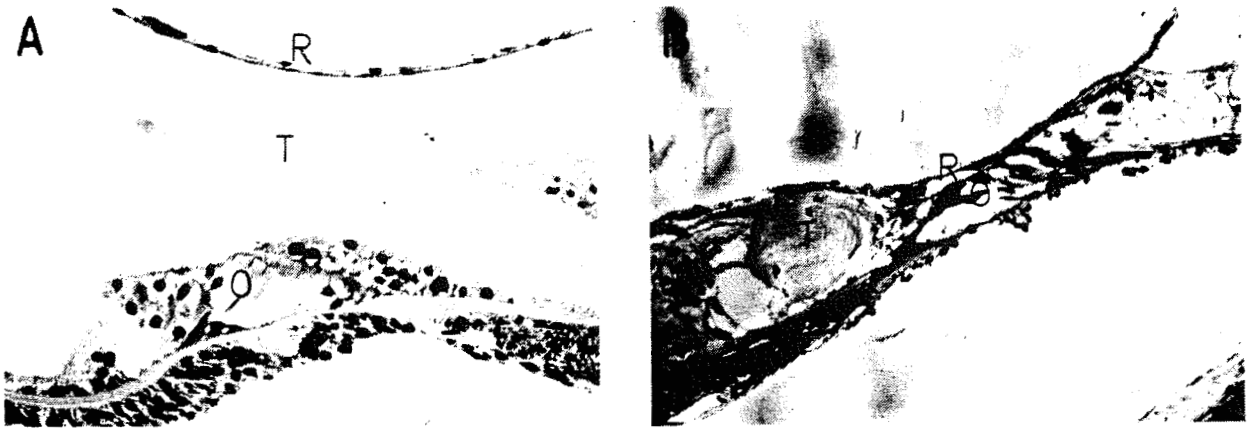


Figure 1. Cochlear duct-basal turn. A: HWM, 30-days-old. B: HWM, 180-days-old. T = Tectorial membrane; R = Reissner's membrane; O = organ of Corti. Note the loss of the cochlear duct, collapse of Reissner's membrane, degeneration of organ of Corti and curled tectorial membrane in the 180-day old HWM. (250 X; Toluidine blue stain).

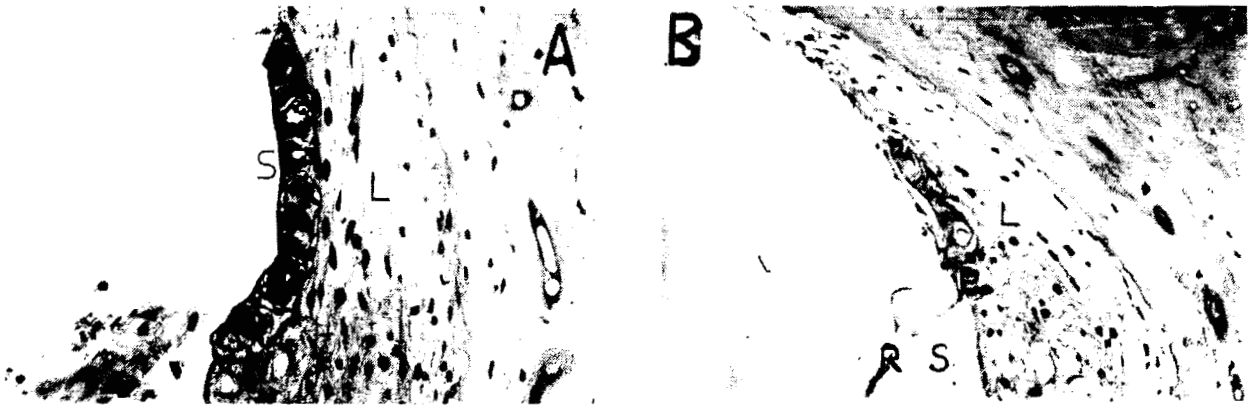
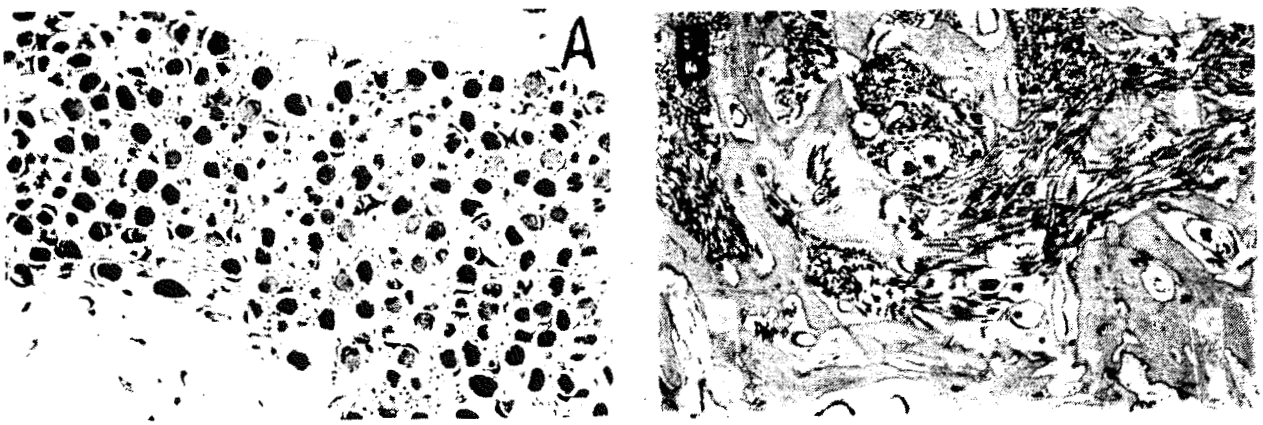


Figure 2. Stria vascularis-middle turn. A: SDM, 180-days-old. B: HWM, 180-days-old. R = Reissner's membrane, S = stria vascularis; L = spiral ligament. Note the difference between the stria vascularis of the 180-day-old SDM and HWM. The stria cells are thinner, vacuolated, and shorter in the HWM. (250 X; Toluidine blue stain).



Figur 3. Spiral ganglion-middle turn. A: SDM, 180-days-old, B: HWM, 180-days-old. Note the decrease in the number of neurons in the spiral ganglion of the HWM compared to the SDM. (250 X; Toluidine blue stain).

Discussion

The ABRs of the SDM had a shape and latencies that were similar to the ABRs of other normally pigmented mammals, including the closely related European ferret (*Mustela putorius furo; Bullock, 1986*) In the mink and ferret, the onset of hearing occurs at 30 days of age; which is later than in most laboratory mammals (*Foss and Flottorp, 1974*).

The progression of pigment-associated sensorineural hearing loss has been well described (*Hilding and Ginzber, 1977*). Melanocytes fail to migrate from the neural crest to the stria vascularis, resulting in the loss of "normal" strial marginal cells that produce endolymphatic fluid. Eventually the organ of Corti degenerates, possibly due to the loss of nutritional or physical support of the endolymph. Because considerable genetic variability occurs between individuals in many species, this may explain the variability in histologic lesions occurring at varying timepoints in the HWM. The variability in the histologic changes could be reflected by variations in the HWM ABRs.

Waves 1 and 2 are normally produced by ipsilateral acoustic stimulus, believed to reflect activity of the eighth cranial nerve (*Hosford-Dunn, 1985*). Waves 3, 4 and 5 result primarily from binaural innervation and represent brainstem activity. The reason only wave 1 (or 2) was present in the ABRs of several HWM is not clear. Waves 1 and 2 were present in 18-day-old hamsters and by 22 days of age, all five waves were seen (*Schwitzer, 1987*). The SDM used in this study presented a complete ABR when tested as early as 26 days of age. It was likely that, as hearing develops rapidly in the SDM, wave 1 was missed because the animals were not tested at a young enough age.

Delay in waves 1 and 3 latencies beginning on day 38 in the HWM could be indicative of changes in the physiologic capacity of the cochlea. The latencies increased and then disappeared. The electrophysiologic changes correspond to histologic lesions that occurred over time in the auditory neural pathway. Failure to consistently demonstrate a brainstem response beyound wave 2 in some of the HWM could be indicative of brainstem pathology (*Glasscock et al., 1987*). A criterion for diagnosing retrocochlear dysfunction proposed by the American Electroencephalographic Society consists of the absence of all waves beyond waves 1 and 2. The absence of later waves in the HWM could be due to degenerative changes that occurred in the auditory brainstem pathway, similar to those found in the blue-eyed white cat (*Schwartz and Higa, 1982*).

When wave 5 latencies occurred in the HWM, the latencies remained essentially "normal" until they disappeared. The normal latencies could be due to the fact that wave 5 is generated primarily by binaural innervation. As only the left (ipsilateral) ear was stimulated, the right (contralateral) ear may have been functioning and so, contributed to the production of wave 5. Later loss of wave 5 could be due to progressive neuronal degeneration of the organ of Corti (*Foss, 1969; Elverland and Mair, 1980; Schwartz and Higa, 1982*). The degenerative changes in the spiral ganglion probably occurred from retro- and anterograde neural degeneration resulting from "disuse" atrophy. If similar brainstem lesions occur in the HWM, it would explain the absence of an ABR beyond the first wave. It is most likely, however, that concurrent degenerative changes occur in the HWM in both the auditory pathway in the brainstem as well as in the cochlea.

It is apparent from behavioral, electrophysiologic and morphologic studies that genetic factors cause a consistent expression of deafness in the HWM. Although blue-eyed white cats, Dalmatian dogs or induction of deafness through use of ototoxic compounds are currently used as models in auditory research, the need for models with "congenital and early acquired profound hearing loss" continues (*Hilding, 1973; Leake et al., 1993*). Because of its consistent and predictable deafness, the Hedlund white mink may serve as a useful animal model for hearing research.

Acknowledgements

The authors would like to thank Chris Bush, Phil Summer and Angelo Napolitano for their assistance with the mink; Dr. David Dolan and

Colleen Sneed for their assistance with protocol; Carol Ayala for her technical assistance and Drs. Steven Bursian and Duane Ullrey for scientific support.

References

Anderson, H., Henricson, B., Lundquist, P., Wedenburg, E., Wersall, J. 1968. Genetic hearing impairment in the Dalmatian dog. Acta Otolaryngol. 232:1-33.

Anonymous. 1986. Recommended standards for normative studies of evoked potentials, statistical analysis of results and criteria for clinically significant abnormality. J. Clin. Neurophysiol. 3:50-53.

Bullock, T. 1986. Interspecific comparison of brainstem and evoked potentials (Chapter 14). In:Evoked Potentials. Alan R. Liss Inc., New York, NY. pp 155-164.

Elverland, H., Mair, I. 1980. Hereditary deafness in the cat - an electron microscopic study of the spiral ganglion. Acta Otolaryngol. 90:360-369.

Flottorp, G., Foss, I. 1979. Development of hearing in heditarily deaf white mink (Hedlund) and normal mink (standard) and subsequent deterioration of the auditory response in Hedlund mink. Acta Otolaryngol. 87:16-27.

Foss, I. and Flottorp, G. 1974. A comparative study of the development of hearing and vision in various species commonly used in experiments. Acta otolaryngol. 77:202-214.

Hilding, D., Ginzberg, R. 1977. Pigmentation of the stria vascularis: The contribution of neural crest melanocytes. Acta Otolaryngol. 84:24-37.

Hosford-Dunn, H. 1985. Auditory brainstem response audiometry - applications in central disorders. Otolaryngol. Clinics N. Amer. 18:257-284.

Leake, P., Snyder, R., Hraek, G., Rebscher, S. 1993. Chronic Intracochlear electrical stimulation in neonatally deafened cats: Effects of intensity and stimulating electrode location. Hearing Res. 64:99-117.

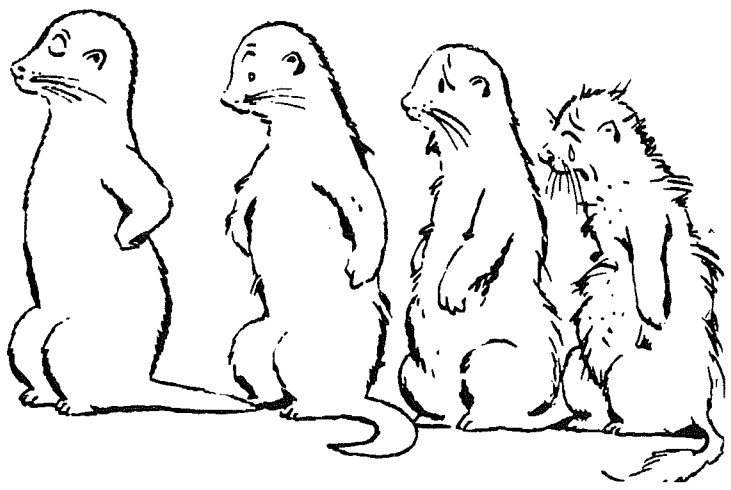
Mair, I., Laukli, E. 1987. Auditory brainstem responses in the cat: Effect of masking level on derived-band contributions. Acta Otolaryngol. 103:586-592.

Powell, R., Zielinski, W. 1989. Mink response to ultrasound in the range emitted by prey. J. Mamm. 70:637-638.

Saunders, L. 1965. The histopathology of here ditary congenital deafness in white mink. Vet. Pathol. 2:256-263.

Schwartz, I., Higa, J. 1982. Correlated studies on the ear and brainstem in the deaf white cat: Changes in the spiral ganglion and the medial superior olivary nucleus. Acta Otolaryngol. 93:9-18.

Schwitzer, L. 1987. Development of brainstem auditory evoked responses in the hamster. Hearing Res. 25:249-255.



Activity of nucleolus organizer regions (NORs) in embryonic hepatocytes from mink twins

G.K. Isakova

Ag-NOR patterns were studied in hepatocytes from nine mink embryo siblings, including a pair of monochorionic (presumably monozygotic, MZ) twins. Both the number and the size of Ag-NORs per cell were found to be identical in MZ twins. All the other sibs had patterns different from each other and from the MZ ones. The conclusion is that the NORs activity is a strongly inherited character and the Ag-NOR pattern can be used as a reliable genetic marker to distinguish twin zygosity.

Genetika (Moskva), 28, 8, pp 60-68, 1992. 4 tables, 43 refs. In RUSS, Su. ENGL. Author's summary.

Species specificity of the distribution of restriction sites in the Bsp repeats in genomes of the canidae

S.V. Ivanov, V.A. Potapov, E.A. Filipenki, A.G. Romashchenko

Similarities and differences in the organization of Bsp repeats in the fox, dog, fennec fox, raccoon, and Arctic fox genomes. The Bsp repeat was specific to the family Canidae. Bsp repeats in all species studied were predominantly organized in clusters. Species-specific features in the distribution of restriction sites in Bsp repeats were found, despite pronounced intra-genomic restriction site polymorphism. These results show that the selection of sets of structural variants of Bsp repeats occured in Canidae genomes during speciation. The greatest similarities in restriction site patterns in Bsp repeats were found between foxes and Arctic foxes, while the most individual pattern was found in raccoons. These results are in agreement with phylogentic relationships within this family.

Translated from Genetika, Vol. 27, No. 6, pp 964-972, 1991. 5 figs., 23 refs. Authors' summary.

Comparison of two mink selection methods

Janusz Maciejowski, Grazyna Jezewska, Jerzy Slawon, Stanislaw Socha

A comparison was made of selection intensity in mink based on two different methods. The first was based on individual exterior evaluation according to criteria valid in Poland. The second was also based on individual exterior evaluation including litter size and origin and uniformity of evaluations within families, where the sum of results of these evaluations constituted an index. Despite considerable differences in selection criteria, the selection intensity for particular traits, measured as selection differential, proved small. According to the authors, both methods are unsatisfactory in exposure of hair cover structure traits. Therefore, a new method of mink exterior evaluation and selection should be elaborated.

Animal Science Papers and Reports (Poland), no. 9, pp 39-46, 1992. 4 tables, 9 refs. Authors' summary.

An attempt at improving the exterior evaluation of carnivorous fur animals

Janusz Maciejowski, Grazyna Jezewska, Stanislaw Socha, Jerzy Slawon

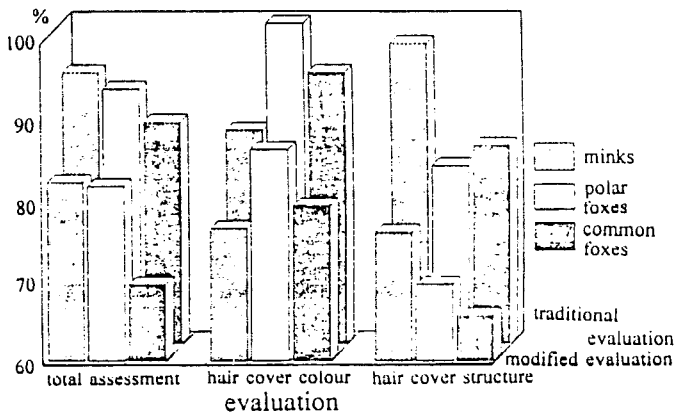


Fig. 1. Mean score of evaluated traits in males of particular species, expressed as deviation from the maximum of 100.

A comparison was made of the results of exterior evaluations of mink, and the polar and common fox, conducted according to two different methods. The authors have proposed a modified evaluation system, involving a reduced number of traits evaluated and a narrowed assessment scale. The score distribution obtained by the modified system more closely approximates the Gauss curve. Moreover, with the narrower score range full advantage is taken of the available points and the judges' work is simplified. The proposed system emphasises the animal-to-animal variation and should contribute to an easier and more effective selection for production traits in carnivorous fur animals.

Animal Science Papers and Reports (Poland), No. 9, pp 29-37, 1992. 7 tables, 2 figs., 8 refs. Authors' summary.

Variation sources on characteristics of adult female chinchillas (*Chinchilla laniger* Gray.) and their offspring in confinement

Ximena Garcia F., Roberto Neira R., Ricardo Scheu

In the Metropolitan region were estimated the effects of the year and season of parturition, ordinal number of parturition, luminosity, weight, kind of birth, length of lactation and gestation, and weight at mating, parturition and postparturition in 316 parturition of 101 female Chinchillas between 1980 and 1986. Also evaluated were the effects of sex, age and kind of birth and breeding on the growth of the offspring. The season of parturition had little influence on the studied variables except on length of lactation, weight at weaning and weight between 5 and 8 months of the offspring. The females who gave birth in summer and fall showed longer lactation. The offspring born in summer weigh less between 5 and 8 months than the norm in other seasons. The weight at weaning of animals born in winter was smaller. The number of the parturitions influenced the majority of the characteristics which showed a lower performance in the first and last parturitions. The analyzed variables were not affected by the level of luminosity. On the other hand, the females located at the lower floor had smaller weights and their offspring grew at a lower rate than the ones located in the upper floors. Twin born Chinchillas had smaller weights at weaning, parturition and postparturition than singles and triplets. The female growth rate was greater than that of the males starting from 6 months of age.

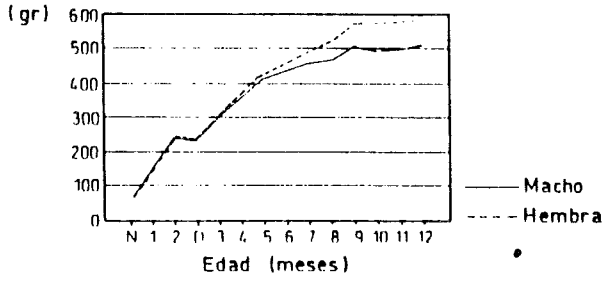


Figura 8. *Efecto del sexo de la cría sobre la curva de crecimiento en* Chinchilla laniger.

Avances en Produccion Animal (Chile), Vol. 16 (1-2), pp 149-156, 1991. 4 tables, 8 figs., 14 refs. In SPAN, Su. ENGL. Authors' summary.

Breeding work with nutria. Part 2.

G.A. Kuznetsov

Colour genotypes and mutations of nutria occurring in the USSR are discussed, and the expected colour of the offspring is tabulated for 55 types of mating for colour.

Krolikovodstvo i Zverovodstvo, No. 5, pp 27-29, 1989. 1 table. In RUSS. CAB-abstract.

Original Report

Reproduction ability in different colour types of nutria

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Summary

Results of a pilot study on the reproduction characteristics and the colour gene inheritance of different genetic colour mutations of nutria (*Myocastor coypus*) is reported. Colour types standard, greenland, silver and albino were included. The animals were kept in cages with pools in a hall. The recorded variables were: the number of live and dead born young per litter at birth and the number of young at weaning, males and females separately. Additionally, the segregation of the young to different colour types was recorded. Besides the albino group, where only one litter was represented, the best reproduction result was observed in the group of greenland mothers.

The genetic background of the parents is discussed on the basis of the segregation of colour types among the young in matings between different colour types of males and females. Albino parents were proved to be homozygous for the albino gene. The standard mothers were mated with standard males and produced only standard coloured young. In other combinations of parent colour types segregation of colours was notices among the young. Suggestions for the true genotype of the parents are made on the basis of previous theories on colour inheritance in nutria. Further investigations are recommended to confirm the suggested genotypes and to clarify especially the effect of the allelic genes in T-locus and the effect of albino gene in combination of t-alleles.

Introduction

Nutria (*Myocaster coypus*) is one of the important furbearing animals. In spite of the critical economic situation in the fur branch, nutria furs are valued and are a desired raw material for the fur industry.

In literature only a few studies concerning the inheritance of colour types in nutria are recorded (Zanker and Tebbe, 1949; Kuznecov, 1964, 1974; Kopanski, 1981; Tocka, 1985).
Greenland ($t^n t^n$) is one of the most popular colour types. The mutant is usually divided into three colour groups; dark, medium and pale.

In the pearl mutation ($t^w t^w$) the colour is very pale, almost white, but with a smoky-beige shade, which is more prominent as a marking along the back. The genotype of steel silver is not quite clear. The opinion of the farmers is that it can be obtained by crossing standard nutria (TT) with recessive mutants pearl ($t^w t^w$), greenland ($t^n t^n$) or sapphire ($t^s t^s$).

Albino (cc) was one of the first mutants to appear among farmed nutria. It is white with red eyes. It is reported that this mutation has reduced fertility and low resistance against environmental effects (Kopanski, 1981).

According to Jarosz (1993) the average number of live born young per litter in the first litter of standard nutria is 5 (fluctuation from 1-13).

Material and methods

The experiment was performed at the Department of Fur Animal Rearing of the Research Institute of Animal Production in Nitra. Five different colour mutants of nutria (*Myocaster coypus*) were used as parents (standard S; greenland G; silver Si; pearl P; white albino A). The first litters of all animals were used in the experiment. The animals were kept in cages with pools in a hall. Three females and one male were kept in one cage. The animals were fed with a granulate mixture for rabbits (KK). Fodder beets were given as supplementary feed. The recorded parameters were: the total number of live born young, number of females and males, and number of stillborn. The young were weaned at the age of 60 days. At weaning, females and males were placed in separate groups with approximately 6-8 animals per cage.

The segregation of colour types among young in mating between different colour types of males and females was recorded in order to discuss the true genetic type of the parents and the inheritance of the colour genes.

SAS statistical programmes (SAS Inst., 1987) were used to calculate the basic statistics (x ± SD) from the results obtained.

Table 1. Average number of young per litter by mother's colour type

Number of young	Standard (S)		Greenland (G)		Silver (Si)		Albino (A)	
	n	x±SD	n	x±SD	n	x±SD	n	x
At birth:								
Total at birth	23	5.1±2.3	6	5.5±2.6	7	5.0±0.8	1	7.0
Live born	23	4.1±1.4	6	5.5±2.6	7	4.1±0.7	1	7.0
Stillborn	23	1.0±1.9	6	0	7	0.9±1.2	1	0
Live born males	23	1.8±1.4	6	3.3±1.9	7	2.6±1.0	1	4.0
Live born females	23	2.3±1.4	6	2.2±1.3	7	1.6±1.1	1	3.0
At weaning:								
Total at weaning	23	3.6±1.5[a]	6	5.5±2.6[b]	7	3.9±0.7[a]	1	7.0
Weaning males	23	1.5±1.3	6	3.3±1.9	7	2.4±1.0	1	4.0
Weaning females	23	2.1±1.3	6	2.2±1.3	7	1.4±1.1	1	3.0

Different letters indicate statistically significant differences between means ($p<0.05$).

Results and discussion

Results of reproduction of different mother colour types are given in table 1.

The one albino mother included in the investigation produced a litter of 7 young. When comparing the average number of young per litter in the 3 other mother colour mutations, the highest number of live born young and number of weaned young was recorded in the greenland group. This corresponds with Jarosz (1993), who reported the greenland mutation as having a very good reproduction ability.

The average litter sizes with greenland, standard and silver mothers were at birth 5.5, 5.1 and 5.0, respectively, and the corresponding figures at weaning 5.5, 3.6 and 3.9, respectively. Thus the survival of the young was also best in the greenland group and at weaning there was a statistically significant difference in the average litter size between the colour types ($p<0.05$). However, the material is very limited and definite conclusions about the reproduction in different colour types can therefore not be drawn. The loss of young between birth and weaning was highest in the standard type; 1.5 young per litter.

Standard females were used in pure breeding with standard males. Likewise, the albino female was mated with an albino male. Greenland females were mated with greenland males or pearl males and silver females were used in matings with silver or albino males. In these four combinations the average litter sizes at birth were 5.3, 6.0, 4.2 and 4.0, respectively.

The segregation of colour types among young in matings between different colour types of males and females is presented in table 2. Matings standard x standard produced 100 % standard coloured offspring and after mating between albino parents only albino young were born. In other colour combinations segregation of colours was noticed among the young.

According to the genetics of nutria colours as presented by Kopanski (1981) the genes for pastel, pearl, sapphire and greenland are allelic genes of the T-locus and all recessive compared to the standard type gene T. A recessive gene in the C-locus is responsible for the albino colour. A closer study of the results of this experiment shows that three combinations of parent colours; greenland x greenland, greenland x pearl and silver x albino have produced about 25 % albino coloured offspring. This gives reason to suspect that the parents have, in addition to the genes responsible for the phenotype of the animal, been heterozygous for other recessive colour genes.

Table 2. The segregation of colour types among youngs in matings between different colour types of parents

Colour types of parents ♀ x ♂	Number of litters	Segregations of colour types of the offspring at weaning										Total number of youngs
		Standard		Silver		Greenland		Pearl		Albino		
		n	%	n	%	n	%	n	%	n	%	
S x S	23	83	100.0									83
A x A	1									7	100.0	7
G x G	4					15	71.4			6	28.6	21
G x P	2					3	25.0	6	50.0	3	25.0	12
Si x A	1					1	25.0	2	50.0	1	25.0	4
Si x Si	6			20	87.0	3	13.0					23
Total	37											150

S = standard A = albino G = greenland P = pearl Si = silver

In the matings greenland x greenland the males and females thus are both suspected of being heterozygous for the albino gene ($t^{a}t^{a}$ Cc). Parents with this genotype would produce 25% pure greenland ($t^{a}t^{a}$ CC), 50% greenland heterozygous for albino ($t^{a}t^{a}$ Cc) and 25% white, genetically greenland albino ($t^{a}t^{a}$ cc). The observed phenotypic segregation 71% greenland and 29% albino is close to the expected segregation of phenotypes.

The segregation of pearl and albino in matings greenland x pearl suggests that both parents must be heterozygous for t^{w} and c. However, the combined effect of multiple heterozygous recessive genes could also possibly produce phenotypes equalling the pale mutations. Thus, if we assume that due to the effect of a single albino gene the genotype $t^{a}t^{w}$ Cc would produce phenotypes which can classify as pearl, the parents in this combination could have genotypes $t^{a}t^{a}$ Cc x $t^{w}t^{w}$ Cc. Of this mating the following genotypes would be expected among the offspring: 25% $t^{a}t^{w}$ CC (phenotype greenland), 25% $t^{a}t^{w}$ cc (phenotype albino) and 50% $t^{a}t^{w}$ Cc (phenotypically probably resembling pearl).

According to Jarosz (*in: Nes et al., 1988*) the silver colour type is a heterozygous form between standard nutria (TT) and one of the recessive genes at the T-locus. The segregation of albino and pearl from mating silver x albino again suggests that hidden recessive genes are present in both parents. However, here the number of offspring of this mating combination is far too small to make any reliable suggestion for the genotypes of the parents.

In the last combination silver ($Tt^{?}$) x silver ($Tt^{?}$) the expected segregation among the youngs should be 25% pure standard (TT), 50% silver ($Tt^{?}$) and 25% recessive t-mutations or their combinations. The achieved numbers of 87% silver, 13% greenland do not fully correspond to the expected segregation. The non-representative result can, however, be due to the limited size of the material.

Conclusion

The results of this investigation support earlier conclusions of the greenland colour type being a prolific type with a good litter size and low early mortality. However, the material in this experiment is not large enough to draw definite conclusions about the reproduction ability of different colour types of nutria.

Suggestions for the true genotype of the parent animals can be made on the basis of the offspring colours achieved. The suggested genotypes must, however, be confirmed by further test matings.

It is our hope to continue the study in the future in order to clarify the genetic background of colour types of nutria especially in regard to the allelic series in T-locus and the effect of the albino gene.

References

Jarosz, S. 1993: Hodowla zwierzat futerkowych. Wydawnictwo naukowe PWN Warszawa-Krakow, p.274.

Kopanski, R. 1981: Chow nutrii, PWRIL, Warszawa.

Kuznecov, G.A. 1964: Bielaja azerbejdzanskaja nutria. Krolokovodstvo i Zvierododstvo, 5, 17.

Kuznecov, G.A. 1974: Genetika okraski nutrij. Krolokovodstvo i Zvierovodstvo, 2.

Nes, N., Einarsson, E.J., Lohi, O., Jarosz, S. and Scheelje, R., 1988. Beautiful Fur Animals - and their Colour Genetics. Scientifur, 271 pp.

Tocka, I. 1985: Chovame nutrie. Vydavatelstvo Priroda, Bratislava, p. 142.

Zanker, S. and Tebbe, F. 1949: Achtung, weisse Sumpfbiber. Der Deutsche Pelztierzuchter, 8, 11.

SAS Institute Inc., 1987. SAS/STAT Guide for Personal Computers, Ver. 6 Edition. Cary, NC, 1028 pp.

Short Communication

The concentration of iron in the blood of polar fox (Alopex lagopus L.) and its effect on female reproduction

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Introduction

One of the most important factors in fur animal feeding is, as well as a proper set of basic nutrients, a wide range of mineral components (ref. 1).

Among the main factors in the animal organism is iron. Over 60% of the iron supply contains haemoglobin. The rest is connected with ferrythin and myoglobin and incorporated in cytochromes and tissue enzymes.

A significant part is serum iron, where permanent exchange takes place. The iron concentration is a result of dynamic development of: haemoglobin disintegration, uptake of iron by bone marrow and tissues, excretion and absorption by alimentary canal. Serum iron connects with transferin, a protein belonging to betal-globulin, which is the iron transporter. In physiological conditions iron saturation of transferin averages from 27 to 44% (ref. 4).

Iron insufficiency in feed, disturbances in its transport or absorption, caused for example by a unilateral diet (containing high levels of certain kinds fish e.g. walfish, whiting), lead to Fe-deficiency anaemia.

A row of characteristic symptoms appear, such as microcyclic and hypochromic anaemia, lack of underfur pigmentation (cotton fur syndrome), severe emaciation, growth retardation, and high mortality (ref. 5).

Iron deficiency in fur animals also causes higher suckling mortality, disturbances in the rearing period, and increased percentage of female cannibalism (ref. 2, 3).

The aim of this study was to compare the values of selected biochemical parameters, concerning iron administration in groups of polar fox females differing from each other in maternal instinct and rearing process.

Materials and methods

The investigations were done in 3 groups of polar fox females (8 vixens each), on a mid-Poland farm, with standard housing and feeding. There were differences in reproduction between these groups of foxes. All females had reproduction experience.

In group A were those females, which had normal maternity behaviour, and whose progeny were reared properly. In group B it was necessary to take the litters away a few days after birth, because of single dying pups. The remaining pups grew poorly. In group C all females destroyed their litters.

Blood samples were collected from the heart, 1 ml of blood on potassium ethylenediamine (tetraautic acid). Next 2 ml of blood were collected for coagulation, and after 30 min centrifuge used to receive serum. Several blood smears were done. The concentration of cations and total iron binding capacity (TIBC) in serum were fixed using Analco (Warsaw, Poland) reagents, basing on common Garcic and Ramsay's methods (ref. 7, 8). TIBC was determined according to entire saturation of transferin by iron and than absorption of its excess by $MgCO_3$.

Latent iron binding capacity (LIBC) was fixed by estimating the difference between TIBC and Fe-cation concentration in serum (ref. 6, 9).

Also estimated were: percentage of transferin saturation by Fe-cations and concentration of transferin in serum, assuming the theory from other authors' calculations that 1 mg of transferin can absorb from 27.1 to 22.1 mmol of iron, depending on the molecular weight of transferin amounting 73000 to 90000 (ref. 9).

The total number of erythrocytes and leukocytes fixed using Coulter Counter, haematocrit using micromethod (haematocrit tubes), and haematoglobin saturation according to common established rules (cyanmethemoglobin method) (ref. 6) were established.

The blood smear was coloured by Wright's prescriptions. 200 leukocytes were counted while evaluating percentage of particular types of leukocytes. The results of the investigation were analysed statistically with t-Student's test.

Results and discussion

Based on the investigations we have concluded that in group A females, which reared their pups correctly, the average saturation of iron in the serum was 24.1 ± 5.2 mmol/l, and TIBC was 49.5 ± 5.4 mmol Fe/l. The degree of transferin saturation was 48.7% in A group, and reached higher values of the norm (ref. 4). These results were confirmed by calculating LIBC, which values were lowest in group A and averaged 25.4 ± 4.8 mmol Fe/l (table 1).

Table 1 Fe saturation, TIBC, LIBC and concentration of transferin (Tf) in investigated groups of polar fox females

Groups	Iron saturation (mmol/l)	TIBC[2] (mmol/l)	LIBC[3] (mmol/l)	Tf[4] (g/l)
A	24.1 ± 5.2[1]	49.5 ± 5.4	25.4 ± 4.8	0.89 ± 0.2 1.1 ± 0.2
B	28.1 ± 7.4	74.9 ± 8.9	46.8 ± 11.4*	1.00 ± 0.3 1.3 ± 0.3
C	28.7 ± 6.9	62.5 ± 8.9	34.1 ± 12.0	1.10 ± 0.2 1.3 ± 2.9

*: Significant difference compared to groups A and C ($p<0.01$)
[1]: Arithmetic mean ± standard deviation from 8 animals in each group
[2]: Total iron binding capacity (TIBC)
[3]: Transferin saturation calculated theoretically

These findings correspond with other author norms for fur animals (ref. 3, 4) and indicate that there were no disturbances in iron administration.

In group B females, that had litters with a large number of dying pups and low litter weight gain. LIBC was significantly higher ($p<0.01$). This indicates that iron saturation of transferin in that group was the lowest and amounted 37%.

There were no significant differences between the rest of the limits related to iron administration. Average transferin content calculated under theoretical specifications regarding molecular weight did not indicate significant differences. This manifests indirectly healthy liver.

Coincidentally there were not detected significant differences in haematological limits. Average values of haematocrit amounted 0.34 ± 0.02 mmol/l, and haemoglobin saturation was 155.1 ± 18.3 g/l. Number of erythrocytes was 4.91 ± 0.34 x 10^{12}/l, leukocytes 7.58 ± 2.03 x 10^{9}; however, percentage of neutrophiles was 52.5 ± 10.4%, lymphocytes 42.6 ± 15.2%, monocytes 0.8 ± 1.1%, eosynophiles 4.1 ± 2.1%.

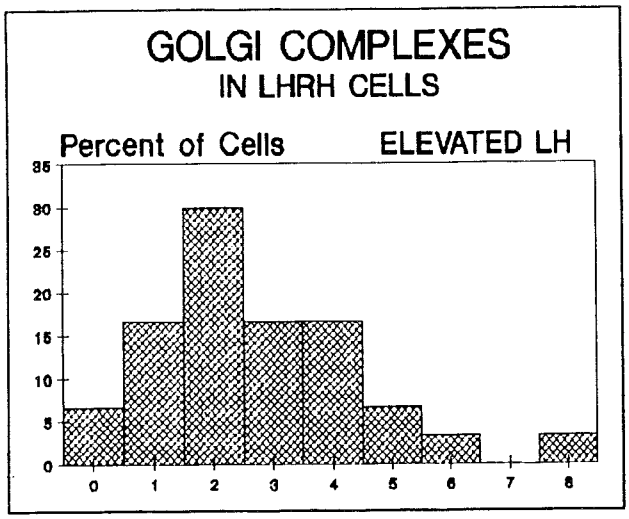
It was revealed, based on these results, that in females with incorrect rearing appeared latent insufficiency of iron, what would indicate the necessity of iron application in the prenatal period.

References

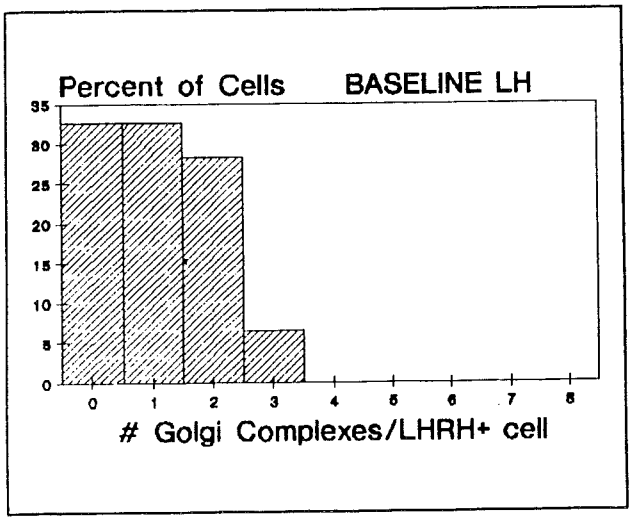
1. Lohi, O., Jensen, L.V. 1991. Mineral composition of mink feed and mink hair. Rep. no. 688 from the Nat. Inst. of Anim. Sci. Research Centre Foulum, Denmark, pp 99-114.
2. Helgebostad, A., Ender, F. 1961. Nursing anaemia in mink. Acta vet. Scand. 2, pp 236.
3. Brandt, A., Mejborn, H. 1987. The effect of iron supplementation on mink kits. Scientifur, Vol. 11, pp 331-338.
4. Brandt, A. 1989. Trace elements in haematology and clinical chemistry of fur animls. Ed. Brandt, A. Scientifur, pp 107.
5. McDowell, L.R. Minerals in animals and human nutrition. Academic Press Inc. Harcourt brace, Jovanovich Publishers, pp 168.
6. Schalm, O.W., Jain, N.C., Carool, F.J. 1975. Veterinary haematology. Lea & Febiger, Philadelphia.
7. Carcic, A. 1979. A highly sensitive, simple determination of serum iron, using chromazurol B. Clin. Chim. Acta vet. 94, pp 115.
8. Ramsay, W.N.M. 1957. The determination of the total iron-binding capacity of serum. Clin. Chim. Acta vet. 2, pp 221.
9. Gepner-Woziewska, M., Sitarska, E., Klucinski, W., Konopka, L., Roszkowski, S. 1977. Transferin expression in different hematological associations. Acta hemat. Pol. 8, pp 21.
10. Aisen, P., Brown, E.B. 1977. The iron binding function of transferin in iron metabolism. Semin. Hematol. 14, pp 31-53.

Vaginocervical stimulation of ferrets induces release of luteinizing hormone-releasing hormone

Carole E. Bibeau, Stuart A. Tobet, Edythe L.P. Anthony, Rona S. Carroll, Michael J. Baum, Joan C. King



A.



B.

Fig. 4. Histogram illustrating numbers of Golgi complexes per section from stimulated (A) and post-stimulated (B) females. Sections analyzed contained the nucleus of LHRH-immunopositive cells.

Vaginocervical stimulation of ovariectomized estradiol-primed ferrets (which are reflex ovulators) with a glass rod in the presence of a neck-gripping male induced an increase in plasma luteinizing hormone (LH) from undetectable levels (≤0.50 ng/ml) before stimulation, to 2.4±0.43 ng/ml 75 min after stimulation (stimulated females). Forty-eight h after stimulation plasma LH returned to baseline levels (post-stimulated females). A significant decrease in the number of perikarya containing LH-releasing hormone (LHRH), detected by immunocytochemistry, was associated with the increase in plasma LH following stimulation. Approximately one half of the number of immunoreactive LHRH neurons (243±27) were detected in the forebrain of stimulated females, compared to those detected in the forebrain of post-stimulated animals (436±88) using antiserum AR 744. Equivalent results were obtained with a different antiserum (RM 1076) capable of detecting the extended decapeptide, or precursor, as well as partially or fully processed decapeptide.

We conclude that controlled vaginocervical stimulation of female ferrets evokes the release of LHRH as well as LH, depleting approximately 50% of the LHRH perikarya of detectable LHRH. Additionally, electron microscopy of LHRH perikarya of stimulated females revealed more Golgi complexes /cell compared to baseline females. We propose that vaginocervical stimulation also augments the processing of extended recursor forms of LHRH to generate the decapeptide.

Journal of Neuroendocrinology, Vol. 3, No. 1, pp 29-36, 1991. 4 figs., 27 refs. Authors' abstract.

Undifferentiated spermatogonia and their role in the seasonally fluctuating spermatogenesis in the ferret *Mustela putorius furo* (Mammalia)

Tosiro Tira, Isao Kita

This study was performed to clarify a mechanism that might be inherent in the spermatogonial population for regulating annual changes in spermatogonial proliferation in a seasonal breeder, the ferret. Three classes of spermatogonia could be discerned: undifferentiated A spermatogonia, differentiated A spermatogonia (A_1, A_2) and differentiated B spermatogonia (B_1, B_2). The undifferentiated A spermatogonia were found to be isolated, paired, or aligned. Cell counts performed throughout the seminiferous epithelial cycle in the breeding season revealed that the number of undifferentiated A spermatogonia

was lowest in the presence of differentiated A_1 and A_2 spermatogonia during stages I-II to III-IV. In the non-breeding season cell counts demonstrated that significant increases in the number of undifferentiated A spermatogonia occurred exclusively during stages I-II to III-IV, when the differentiated A_1 and A_2 spermatogonia degenerated. These results suggest that the reaction of the undifferentiated spermatogonia after cell loss during the non-breeding season is strictly local. The enhanced proliferation of undifferentiated spermatogonia may serve as preparation for the recommencement of spermatogenesis during the next breeding season.

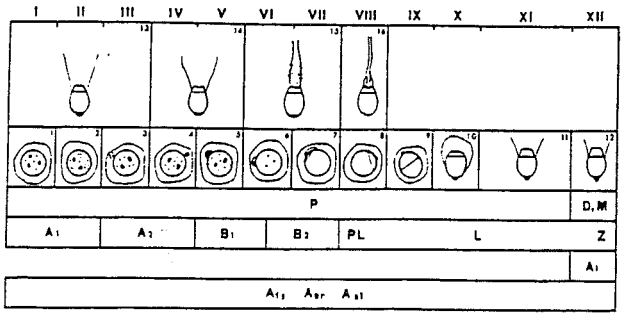


Fig. 1. Cycle of the seminiferous epithelium in the ferret. I-XII: Stages of the cycle, 1-16: Steps of spermiogenesis, A_{in}, A_{pr}, A_{al}: Undifferentiated type A spermatogonia, A_{in}: Isolated type A spermatogonia, A_{pr}: Paired type A spermatogonia , A_{al}: Aligned type A spermatogonia, A_1: Differentiated type A_1 spermatogonia, A_2: Differentiated type A_2 spermatogonia, B_1: differentiated type B_1 spermatogonia, B_2: Differentiated type B_2 spermatogonia, PL: preleptotene primary spermatocytes, L: Leptotene, Z: Zygotene, P: Pachytene, D: Diplotene and diakinesis, M: Meiosis

Zool. Anz. 224, 3/4, pp 140-155, 1990. 7 tables, 19 figs., 20 refs. Authors' abstract.

Effect of ovariectomy on blastocyst expansion and survival in ferrets (*Mustela putorius furo*)

Ann C. McRae

The initial objective was to investigate whether progesterone alone can support full blastocyst expansion in ferrets ovariectomized on Day 5 post coitum (p.c). By day 11 p.c. blastocysts from control animals had expanded to ~ 2000 μm in diameter, whereas by days 11 or 14 p.c. blastocysts from ovariectomized animals given progesterone had diameters of <1000 μm. Thus, ovarian factors in addition to progesterone are apparently required for normal blastocyst expansion in this species. Subsequent experiments indicated that an initial stage of expansion (from ~ 200 μm to ~ 400 μm) occurred regardless of whether ovariectomy was performed on day 2 or 3 p.c. A second stage of expansion resulted in blastocysts of ~ 700 μm in diameter and it occurred in ovariectomized animals if progesterone was given or if ovariectomy was delayed until day 5 p.c. A third phase of expansion resulted in blastocysts of ~ 2000 μm in diameter and occurred only if ovariectomy was delayed until day 8 p.c. Although blastocyst expansion appeared normal in these animals, implantation did not occur in the absence of progesterone replacement. In addition, blastocysts retained in the oviduct by ligation of the uterotubal junction failed to expand beyond ~ 400 μm in diameter. These results suggest that progesterone acts upon the uterus to promote blastocyst expansion up to a diameter of ~ 1000 μm and that additional ovarian factors are required for further blastocyst expansion.

Reprod. Fertil. Dev., 4, pp 239-247, 1992. 2 tables, 23 refs. Author's abstract.

Comparative vaginal cytology of the estrous cycle of black-footed ferrets (*Mustela nigripes*), siberain polecats (*M. eversmanni*), and domestic ferrets (*M. putorius furo*)

Elizabeth S. Williams, E. Tom Thorne, Donald R. Kwiatkowski, Kim Lutz, Sandy L. Anderson

Vaginal cytology and vulva size were used to characterize the reproductive cycle of female black-footed ferrets (*Mustela nigripes*), Siberian polecats (*M. eversmanni*) and domestic ferrets (*M. putorius furo*). Emphasis was on black-footed ferrets because of the need to breed these critically endangered animals and on Siberian polecats because of the close taxonomic relationship to black-footed ferrets. Vaginal cytology of the 3 species of ferret is similar. Proestrus was characterized by an increasing percentage of superficial epithelial cells and enlargement of the vulva. During estrus, superficial cells were usually ≥90% of epithelial cells in the vaginal lavage and after several days were fully keratinized. Neutrophils were more common during all stages of the estrous cycle in domestic ferrets than they were in the other species. Following

copulation, percentage of superficial calls in the vagina declined and vulva swelling subsided. Large cells, probably of uterine symplasma origin, were observed in vaginal lavages following whelping or pseudopregnancy. Vaginal cytology is extremely useful in the reproductive management of black-footed ferrets and Siberain polecats. Knowledge of normal vaginal cytology could be applied to the diagnosis of female reproductive abnormalities in all 3 species.

J Vet Diagn Invest 4, pp 38-44, 1992. 1 table, 5 figs., 26 refs. Authors' summary.

Correlation of testicular size to fecal steroid concentrations in the black-footed ferret

C.M. Wieser, T.S. Groos, M. Patton

The black-footed ferret (*Mustela nigripes*) is an endangered North American mustelid (*Seal et al., 1989*). Black-footed ferrets are seasonal breeders and the male exhibits testicular recrudescence during the breeding season (*Nalbandov, 1976*). A non-invasive method to chart testosterone levels and correlate testicular size in the male ferret would improve the understanding of their reproductive behaviour. Such techniques would be less stressful for the animal than traditional sampling methods and can be used in the field once the ferret is reintroduced to the wild. Six male black-footed ferrets ranging from one to two years of age were measured on a weekly basis and fecals collected. Fecal samples were solubilized and extracted prior to analysis for testosterone using a competitive binding assay (radioimmunoassay: RIA). Fecal testosterone concentrations correlated (R^2=0.8432) with testicular size; both increasing during February and March. High fecal testosterone concentrations (8.4±1.5 ng/0.5 g feces) were observed from late March through early May, when testicular size was maximized and when breeding behaviors were observed. Fecal testosterone concentrations (R^2=0.6988) decreased during mid to late May for each male prior to any significant decrease in testicular size (R^2=0.8714). Breeding behaviors and breeding success decreased when fecal testosterone concentrations were significantly lower. This data indicates that a non-invasive method for measurement of testosterone in black-footed ferrets is possible. These methods offer the opportunity for monitoring reproductive potential in male black-footed ferrets by a non-invasive measurement of fecal testosterone concentrations.

Animal keepers' forum ((SA), Vol. 19 (11), pp 389-393, 1992. 12 refs. Authors' abstract.

Original Report

Effect of fat and carbohydrate diet on digestive enzyme activity in mink blood and organs

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Summary

The activity of digestive enzymes in blood serum, pancreas, mucosa of stomach and small intestine was studied in mink males whose diet during ten days had a high content of fat or carbohydrates. No correlation between the diet composition and the activity of digestive enzymes in blood and organs as well as between enzymatic activity in organs and blood indices was revealed.

Introduction

One of the adaptation mechanisms of the digestive system to diet composition is a change in digestive enzyme activity so that nutrient hydrolysis goes better. It was shown on rats and other animals: when the protein content in the diet increases the activity of proteolytic enzymes grows, when the fat content increases, the activity of lipolytic enzymes grows, and when the carbohydrate content increases, the activity of carbohydrate enzymes grows (*Ugolev et al., 1986*). Little information is available about the effect of diet on digestive enzyme activity in predators (*Simoes-Nunes et al., 1984; Berestov et al., 1988; Flammand & Belsile, 1988*).

The aim of the present work was to assess the effect of different diets on the activity of digestive enzymes in stomach, pancreas, small intestine and blood of mink.

Another purpose was to investigate the degree of relation between digestive organ enzymes and blood indices.

Materials and methods

The experiments were performed on standard colour male mink a year and a half old. In July blood samples were taken from the animals (initial level). In September the animals were divided into three groups, each of 6 specimens. One group obtained food with an increase of up to 50% content of fat at the expense of vegetable oil (Exp. 1), the second one - with the increased content of carbohydrates at the expense of starch (Exp. 2). The control group received a standard diet. The approximate composition of the diets with caloric values is presented in table 1. Ten days after the beginning of the experimental diet blood samples were taken from the animals. After that all animals received standard diet.

Table 3 Thickness of guard hairs and undercoat in standard male nutria when feeding browse

Parameter		n	Experiment (n=15) M ± SD	Control (n=15) M ± SD
Guard hair	Back	750	172.20 ± 22.35	177.76 ± 16.90
	Abdomen	750	127.20 ± 30.23	125.85 ± 24.08
Undercoat	Back	300	12.233 ± 3.357	15.033 ± 2.792^{++}
	Abdomen	300	9.867 ± 1.836	11.767 ± 3.647^{++}

$^{++}$ $P \leq 0.01$

Table 4 Results of coprological examination of parasite occurrence in the digestive tract of standard male nutria during growth using browse feeding

Age (months)	Cage No.	n	Type of parasitosis	State of invasion
5	1	3	E.m., St.m.	medium
	2	3	E.m., E. pel.	medium
	3	3	E.m., E. pel.	medium
	4	3	Trich. m.,	medium
	5	3	E.m., E. pel., Trich.m.	medium
6	1	3	E.m., E. pel.	medium
	2	3	E.m., E. pel., Trich.m.	medium
	3	3	E.m., E. pel.	medium
	4	3	E.m., E. pel.	medium
	5	3	E.m., E. pel.	medium
7	1	3	E.m., E. pel., E.s., Trich.m.	medium
	2	3	E.m., E. pel., E.s., Trich.m.	medium
	3	3	negative	
	4	3	negative	
	5	3	E.s., Trich.m.	medium
8	1	3	E.m., E. pel.	medium
	2	3	E.m., E. pel.	medium
	3	3	negative	
	4	3	E.m., E. pel.	medium
	5	3	E. pel	medium

E.m. - Eimeria myopotami
S.m. - Strongyloides myopotami
E. pel. - Eimeria pellucida
Trich. m. - Trichocephalus myocastoris
E.s. - Eimeria seideli

Table 5 Results of coprological examination of parasite occurrence in the digestive tract of standard male nutria during growth with additional beet feeding without an anticoccidic application

Age (months)	Cage No.	n	Type of parasitosis	State of invasion
5	1	3	E.m., Trich.m.	medium
	2	3	E.m.	medium
	3	3	E.m., E. pel., St.m., Trich.m.	medium
	4	3	E.m., E. pel.	medium
	5	3	E.m., E. pel., St.m., Trich.m.	medium
6	1	3	E.s., Trich.m.	medium
	2	3	E.m., E. pel.	medium
	3	3	E.m.	medium
	4	3	E.m., E. pel.	medium
	5	3	E.m., Trich.m.	medium
7	1	3	E.m., E. pel., E.s.	medium
	2	3	E.m.	medium
	3	3	E.m., E. pel.	medium
	4	3	negative	
	5	3	E.m., Trich.m.	medium
8	1	3	E.s., E. pel.	medium
	2	3	Trich.m.	medium
	3	3	E.m.	medium
	4	3	negative	
	5	3	negative	

E.m. - Eimeria myopotami
S.m. - Strongyloides myopotami
E. pel. - Eimeria pellucida
Trich. m. - Trichocephalus myocastoris
E.s. - Eimeria seideli

The difference in appendix volume as an important organ for fibre digestion was not statistically confirmed in spite of increased content of fibre in browse compared with fodder beet. Neither was confirmed the significance of differences in liver weight.

The value of fur of nutria depends first of all on the quality of the covering components of the fur (*Kopanski, 1965; Wenzel, 1980*). We can confirm neither the assumption of Kopanski (1965) and Malik et al. (1974) nor the widespead opinion in breeding practice of the positive influence of browse additive on the qualitative properties of nutria fur on the basis of our results. The statistical significance of breadth in guard hairs which is one of parameters of fur durability was not confirmed as it follows from results given in table 3. Statistical significance of differences on behalf of the control group ($P \leq 0.01$) was observed in undercoat thickness. It is clear from the above mentioned facts that the specific substances which are contained in browse do not have direct impact on kreatin synthesis.

Scheuring (1983) stresses the fact that browse influences positively the state of health in wild

living nutria. Salicylates are known as having bacteriocide effects. Tanning matters can also have a specific influence from the viewpoint of health. Increased content of fibre influences positively the peristalsis of the gut as well as mechanical explosion of parasites from the animals (*Krejci et al., 1989*).

Parasitological examination of the experimental and two control groups show that the spectrum of parasitical species in the digestive tract of nutria did not change. The presence of parasites in droppings was rare in the group treated with coccidiostatics (it was negative in some cases).

Medium invasion of parasites of the genus Eimeria, Strongyloides and Trichocephalus (tables 4, 5, 6) was found in the experimental group as well as in the group fed with beet without Sulfakombin additive.

The above mentioned results show that feeding the browse from willow influences positively the need to gnaw reflexively as well as some ethological activities of animals. Its administration can be recommended mainly in small herds. There is no reason to use it in more intensive forms of rearing.

Table 6 Results of coprological examination of parasite occurrence in the digestive tract of standard male nutria during growth with additional beet feeding with Sulfakombin application

Age (months)	Cage		Type of parasitosis	State of invasion
	No.	n		
6	1	5	E.m., St.m.	rare finding
	2	5	E.m., E.s.	rare finding
	3	5	negative	
	4	5	E.m., E.s., Trich.m.	rare finding
7	1	5	E.m.	rare finding
	2	5	E.m., E. pel., Trich.m.	rare finding
	3	5	negative	
	4	5	Trich.m.	rare finding
8	1	5	negative	
	2	5	negative	
	3	5	negative	
	4	5	E.m., E. pel.	rare finding

E.m. - Eimeria myopotami
S.m. - Strongyloides myopotami
E. pel. - Eimeria pellucida
Trich. m. - Trichocephalus myocastoris
E.s. - Eimeria seideli

References

Caba, S.M., Barry,, T.N. 1988. Nutritive value of villou (Salix sp.) for sheep, goats and deer. J. Agric. Sci., 3, 1, pp 1-9.

Kladovscikov, V.F. 1979. Kletocnoe rozvedenie nutrij. Rosselchozdat, Moskva, pp. 48.

Kopanski, R. 1965. Zarys futrzarstwa. PWNL. Warszawa, pp. 26-30 + 95-102.

Komarek, V. 1991. Biologicke zaklady prolovnej zveri. Priroda, bratislava, pp 106-108.

Krajci, P. 1989. Zdravotna starostlivost v drob nochove. Priroda, bratislave, pp 446-448.

Kukla, F. 1977. Chov kozesinovych zvirat. VSZ Brno, p. 132.

Malik, V. 1974. Moderny chov kralikov a kozusinovych zvierat. Priroda, Bratislava, pp 86-87.

Prokopenko, V.V., Lopatka, M.V. 1981. Korma z lesnych ugodij. Kormoproizvodstvo, 12, p. 10.

Scheuring, W. 1983. Choroby nutrii. PWNL, Warszawa, pp 106 + 150.

Skrivan, M. 1976. Chov kozesinovych zvirat. SZN, Praha, p. 240.

Wenzel, U.D. 1980. Stumfbiber, VEB, Berlin, p. 79.

The amino acid sequence of the double headed kazal-type proteinase inhibitor from mink (*lutreola lutreola*) and marten (*martes foina*) submandibularis glands

Michael Greim

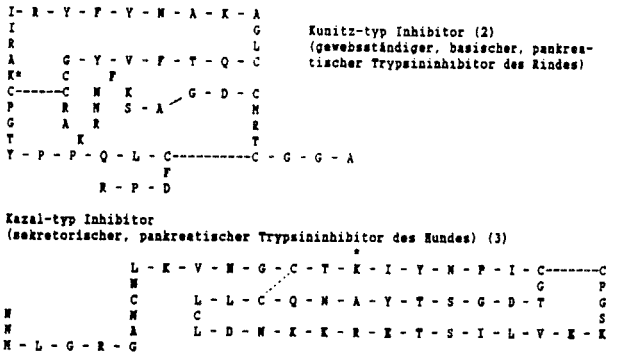


Fig. 1. Schematische Darstellung der Primär- und Sekundärstruktur von Kunitz- und kazaltyp Inhibitoren. (*) = reaktive zentren, (----) = Disulfidbrücken

The trypsin inhibitors with an additional inhibition effect against chymotrypsin and the elastases of pancreas and PMN-granulocytes from mink and marten submandibular and parotis glands were identified as double-headed Kazal-type inhibitors. The cleaned, reduced and carboxymethylated inhibitors were cracked proteolytically and its cracking products were cleaned by different means until uniformity was reached.

The ortho-phthalaldehyd-method with precolumn-derivatisation for the analysis of amino acids was used. The sequence analysis occurred by means of Edman degradation in the automatic solid- or rather manual liquid-phase method.

The primary structure was saved by the comparison of the sequences of the cracking products with the sequences of homologue inhibitors of submandibularis glands of other species of animals.

The double headed inhibitor's structure with a separation derivation of the relation between function and structure and herewith of the inhibition specification.

The inhibition specification was confirmed through the determination of the intact inhibitors' inhibition effect of trypsin in the N-terminal domain and chymotrypsin as well as Elastase of pancreas and PMN-granulocytes in the C-terminal domain.

Because of amino acid sequence analysis it was possible to prove a point of glycosylation in position 20 of LuSI.

Furthermore, the existence of an isoinhibitor without a point of glycosylation could be confirmed.

Aus der Klinik und Poliklinik für Hals-, Nasen- und Ohrenkranke der Medizinischen Fakultät der Ludwig-Maximilians-Universität München, Germany. Thesis, 71 pp, 1991. 16 tables, 46 figs., 24 refs. Author's summary.

Stimulatory and inhibitory regulation of calcium-activated potassium channels by guanine nucleotide-binding proteins

Hiroaki Kume, Michael P. Graziano, Michael I. Kotlikoff

The regulation of membrane ion channels by guanine nucleotide-binding proteins (G proteins) has been described in numerous tissues. This regulation has been shown to involve the membrane-delimited stimulatory action of G proteins on ion channels. We now show that single calcium-activated potassium channels (K_{Ca} channels) in airway smooth muscle cells are both stimulated and inhibited by G proteins in membrane patches. We demonstrate that the ß-adrenergic agonist isoproterenol stimulates channel activity via the α subunit of the stimulatory G protien of adenylyl cyclase, G_s, and that channel opening is inhibited by the action of the muscarinic agonist methacholine, acting via a pertussis toxin-sensitive G protein. Isoproterenol stimulated and methacholine inhibited channel activity in the same outside-out patches when GTP was present at the cytosolic surface of the patch. In inside-out patches, addition of GTP and guanosine 5'-[γ-thio]triphosphate (GTP[γS] augmented channel activity when isoproterenol was included in the patch pipette, and inhibited channel activity when methacholine was included in the pipette. Consistent with these results, in the presence of GTP[γS], the α subunit

of G_i (α_iGTP[γS] complex) opened K_{Ca} channels in a dose-dependent manner, whereas in the presence of guanosine 5'-[ß-thio]diphosphate, α_i had no effect. By contrast, application of activated α_i or α_o proteins did not inhibit channel activity in inside-out patches, indicating that channel inhibition is more complex than a simple α subunit/channel interaction, similar to the complex inhibitory regulation of adenylyl cyclase. These results suggest that hormonal regulation of K_{Ca} channels shares substantial features with the regulation of adenylyl cyclase and demonstrate that a single ion channel may serve as the regulatory target for the membrane-delimited action of stimulatory and inhibitory G proteins. Moreover, they demonstrate a potentially important functional pathway by which ß-adrenergic and other G_s-linked receptors stimulate relaxation of smooth muscle, independent of cAMP-dependent protein phosphorylation.

Proc. Natl. Acad. Sci (USA), Vol. 89, pp 11051-11055, 1992. 1 table, 4 figs., 45 refs. Authors' abstract.

Influence of trace elements on growth and reproduction of mink

M. Anke, E. Salchert

Growth and feed intake of male and female mink were studied from July 1988 to November 1989. The mink were fed on a conventional diet supplemented with Edapan (vitamin/mineral mix), or that diet without manganese, copper, zinc or iron, or unsupplemented (groups 1 to 6). From January to May in 1989, 1990 and 1991, pregnant mink were given feeds with Edapan with or without Zn. Average trace element content in mink feeds exceeded requirements; therefore differing trace element supply did not affect growth or feed intake. However, dietary Zn intake influenced fur composition. When breeding females were given Zn 6 mg/day, litter size decreased from 5.45 (Zn 10 mg/day) to 4.47.

Biologische Fakultät der Friedrich-Schiller-Universität Jena, Germany. 1991. 7 tables, 5 refs. In GERM. CAB-abstract.

Liver histology in female mink (*Mustela vison*) after treatment with commercial polychlorinated biphenols (PCBs) and fractions thereof during the reproduction season

A. Bergman, B.M. Backlin, B. Jarplid, L. Grimelius, E. Wilander

This study is part of an experimental investigation of effects of PCBs in mink initiated by the Swedish Environmental Protection Agency; Project seals and protection of seals. Further information on the study will be given in Ambio, published by the Royal Swedish Academy of Sciences, Stockholm.

The mink has shown to be very sensitive to PCBs. Most adverse effects have been observed at exposure to CB congeners unsubstituted with chlorines in ortho-positions i.e. non-ortho-(0-ortho-) CBs. At PCB toxicosis pathological changes have been observed mainly in the integumentary, reproductive, lymphatic, and alimentary organ systems.

Effects upon liver histology were studied in groups of 10 female mink after treatments, for 79-96 days during the reproduction seasons in 1988 and 1989, with commercial polychlorinated biphenyls (Clophen A50 and Aroclor 1254) and fractions thereof containing different chlorobiphenyl (CB) congeners, and, a fraction containing bi- and tricyclic contaminants mainly representing traces of polychlorinated dibenzofuranes and polychlorinated napthalenes. In 1988 one group was treated with Clophen A50 (2 mg daily/animal). Other groups were treated with different fractions of Clophen A50, viz.; the fraction containing CB congeners with two to four chlorines in ortho-positions (2-4-ortho-CBs) (a), the fraction containing CB congeners with one chlorine in ortho-position (1-ortho-CBs) (b), the fraction containing CB congeners with no chlorine in ortho-positiion (non-ortho- or 0-ortho-CBs) (c), and, the fraction containing bi- and tricyclic contaminants (d). One group was treated with a synthetic mixture of three 0-ortho-CBs; 3,3',4,4'-tetrachlorobiphenyl, 3,3',4,4',5-pentachlorohiphenyl, and 3,3',4,4',5,5'-hexachlorobiphenyl (e). The daily

treatment doses/animal with the a-e compounds were equivalent to those present in 2 mg of Clophen A50. In 1989 one group was treated with Aroclor 1254 (1.64 mg daily/animal). Other groups were treated with different combinations of the a-d fractions in daily amounts/animal equivalent ot those present in 1.64 mg of Aroclor 1254.

Some histological changes viz.; fatty changes of hepatocytes, hemosiderosis of Kupffer cells, frequency of polymorphonuclear cells, and frequency of mononuclear cell reactions, were selected and used as parameters at semi-quantitative estimations of the effects on the liver histology. High incidences of changes were found in groups exposed to commercial PCBs, combinations of three and four different CB-fractions, and at exposure to the combination of 1-ortho- and 2-4-ortho-CBs in the 1989 experiment, compared to groups treated with single CB fractions and the group treated with the synthetic CB mixture in the 1988 experiment. The least effects in animals treated with combinations of CB fractions were found at exposure to 2-4-ortho- and 0-ortho-CBs. At treatment with single CB fractions, very slight effects were observed in the group treated with 2-4-ortho-CBs and no effects at all were observed in the group given bi- and tricyclic contaminants. The degree of liver changes were ascribed to additive effects of different compounds rather than to specific effects of single compounds present in the commercial PCBs.

Dansk Veterinærtidsskrift, 75, 13, pp 567-568, 1992. 3 refs. Only summary recieved. Authors' summary.

Using preserved nutria blood in diets for polar foxes and chemical structure and some physical traits of their pelts

M. Maciejewska, H. Bieguszewski, T. Pietryga

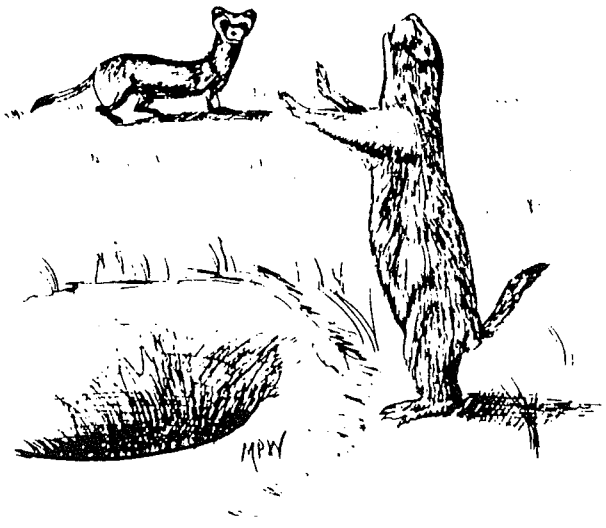
In the experiment there were 10 young polar foxes divided into 2 groups, the first being the control group. The animals obtained ad libitum feed containing 50% plant components and 50% animal components. In the rations of the animals in the experimental group 20% of the animal component was substituted by nutria blood preserved with sulphuric acid and sodium benzoate. The coat samples for laboratory investigations were taken after 4 and 8 weeks of the experimental feeding. After 4 weeks the relations of keratose fractions were $\alpha\beta:\gamma = 70:30:20$ while in the samples from the control animals they were 50:30:20. The differences were statistically highly significant. After 8 weeks of giving experimental feed the contents of keratose fractions was close to those in the control animals, which would show adaptation of animals with time to new feed components.

Among the physical parameters only the content of suint was observed to grow significantly after addition of preserved nutria blood.

Akademia Techniczno-rolnicza w Bydgoszczy, Zeszyty Naukowe, Zootechnika, 20, 175, pp 79-84, 1991. In POLH, Su. ENGL, RUSS. 2 tables, 4 figs. Authors' summary.

Zinc phosphide: black-tailed prairie dog-domestic ferret secondary poisoning study

George H. Matschke, Keith J. Andrews, Richard M. Engeman



A laboratory study was conduced in which tissues from zinc phosphide-killed black-tailed prairie dogs (*Cynomys ludovicianus*) were fed to domestic ferrets (*Mustela putorius*). Prairie dogs were fed a 2.03% zinc phosphide bait and upon death, two tissue complexes were prepared: sto-

mach, liver, and intestines, and the remaining carcass. Five male and five female ferrets were each fed one of the two treated tissue complexes. A similar number of ferrets were each fed one of the two control tissue complexes. No poisoning symptoms or emesis were observed and no ferret mortality occurred. Zinc phosphide residue was determined in 10 prairie dog carcasses; 99.9% was found in the stomachs and small intestines. Residues were also detected in the large intestine, caeca, kidneys, and gall bladder/liver, none were found in the lungs, heart, or muscle. The low amounts of zinc phosphide remaining in the carcasses, the absence of ferret mortality, poisoning symptoms or emesis, despite the emetic properties of zinc phosphide, confirm that the risk of secondary poisoning from zinc phosphide is unlikely.

Proc. 15th Vertebrate pest Conference (15), pp 330-334, 1992. 3 tables, 1 ref. Authors' abstract.

On the use of chlorella in mink feeding

I.Z. Akhmetov

A chlorella paste was added to the diet of adult and growing mink, in amounts to replace up to 30% of animal protein. It increased feed intake and utilization of protein, fat and minerals and accelerated physiological processes.

Sel'skokhozyaistvennaya Biologiya, No. 6, pp 85-88, 1991. 2 tables, 9 refs. In RUSS, Su. ENGL. CAB-abstract.

Original Report

Wet mink kits, an epidemiologic investigation on risk factors

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Royal Veterinary and Agricultural University,

Sect. for Ethology and Health, DK-1870 Frederiksberg C, Denmark

Introduction

Diarrhoea in young mink kits has been described in 1952 by Momberg-Jørgensen (1), but the syndrome, wet mink kits, was first detected as being a problem in the 80's. The causes for the appearance of the syndrome are still unknown but, beyond any doubt, many factors are involved in triggering off the syndrome. Wet mink kits are seen at the age of 14 to 25 days, but may appear at the age of a few days. The whole litter will develop the wet appearance.

The mink kits whimper and the female decreases the time spent in the cage with the mink kits. Initially the mink kits show signs of diarrhoea and the bellies are distended. The region around the anus is red and sore. Minor wet exudations are seen around the paws and the eyes. Exudations soon cover the whole body and dehydration appears. Dirt in combination with the exudation give the mink kits an armoured look. If the mink kits are left untreated, they will die due to strong dehydration.
The incidence risk of wet mink kits varies among farms. The normal incidence risk varies from 1 to 10% but every year farms report on incidence risks up to 100% of all the litters.

The mortality risk of wet mink kits is normally low when the treatment of the litters has been implemented early. In farms with high incidence risks the lack of manpower will influence institution of a sufficient and early treatment for which reason massive death can be seen. In these farms a mortality up to 50% has been reported.

Material and methods

In 1992 the Danish Fur Breeders Association performed a questionnaire sampling on 125 Danish mink farms. This study was carried out in a case-control design. The purpose of the study was to identify risk factors associated with furbiting. Information about management-procedures and production-facilities for the production-year 1990 was sampled by one person with personal interviewing of the mink farmer.

So far no association has been established between furbiting and wet mink kits. Therefore this study can, with regard to wet mink kits, be considered as a retrospective longitudinal study design.

The unit of concern is the mink farm and all analyses have been performed on a farm level.

Student t-test, chi-square have been used in the statistical analyses. The statistical package SAS® was used for the analyses.

Results

In this investigation 7 mink farmers did not specify whether wet mink kits were observed on their farms. 62 farmers (49.6%) stated that wet mink kits were observed. The incidence risk varied from 0.2% up till 90% of the litters. On the average 11.9% of the litters were affected (figure 1)

To avoid diagnostic misclassifications only farms that reported more than 5% wet mink kits (33 farms) in the following are used as problem farms.

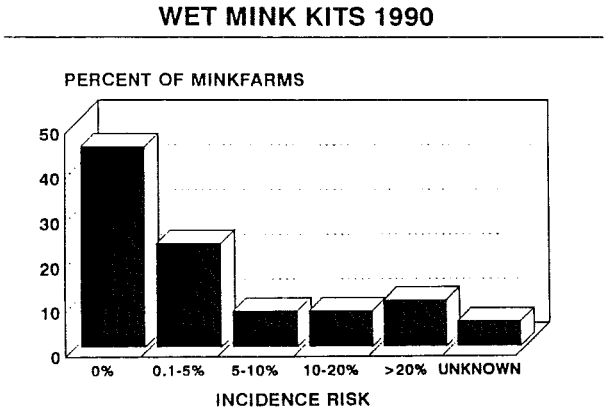

Figure 1. The incidence risk of wet mink kits in the 1990-study. Approximately 50% of the farms reported that wet mink kits were observed

The average farm size did not differ significantly (p=.12) but the group of farms, where no wet mink kits were observed, had 730 females per farm. The farms with wet mink kits had a tendency of being larger up to an average farm size of 954 females.

The production results did not differ between the two groups of farms. The average litter size at birth (p=.39) and the average number of weaned kits were not statistically significant (p=.15) (figure 2).

The management procedures did not differ significantly by means of the number of full time employes (p=.07), nor the number of females per full time employes (p=.65). There is, though, a tendency to attend more females on the farms with wet mink kits.

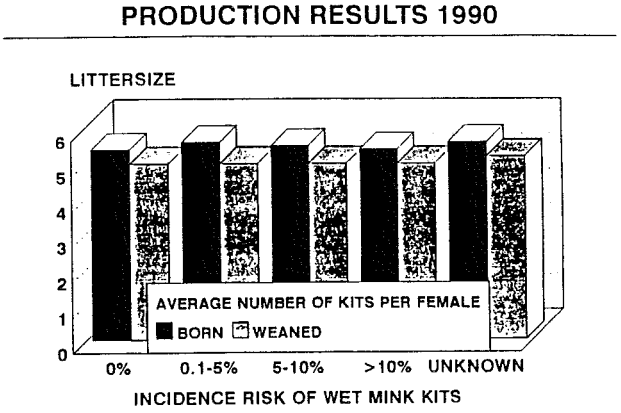

Figure 2. Production results for farms with increasing incidence risk of wet mink kits. The average loss of kits is 0.45 per litter

The production facilities are very similar in both groups. The farms consist of open as well as closed sheds (p=.45) and are placed in the same direction (p=.79). The cagesize (p=.99), the type of shelter (p=.36), the straw material (p=.23) and the manure system (p=.38) seemed to be more or less identically distributed between the two groups of farms.

The level of hygiene was evaluated by observing the weeks between cleaning out the dung. Farms without problems did that every 3.1 week, whereas farms with more than 5% wet mink kits removed the dung every 2.2 week (p=.11). The shelters were on almost all farms, thoroughly cleaned once a year (p=.30). The mink kit net, which is put at the bottom of the cage mid-April, is cleaned approximately every 4th week (p=.58). The amount of straw used (p=.15), the frequency of giving new straw (p=.88), cleaning of the feeding truck (p=.79=, and cleaning of the feed silo (p=.79) showed no difference between the two groups.

Only 50% of the farms reported that fleas were found (p=.98) but almost all farms were treating prophylactically against fleas. Only 5 farms reported about problems with resistant fleas. The water sources of the farms were both from private wells and public waterworks (p=.32). There is a tendency to have a higher pressure on the

mink water supply on the mink farms with wet mink kits (p=.55). The water works are desinfected and cleaned up to 7 times a year (p=.18), and the water nipples up to 4 times a year (p=.13). About half the farms use additional water supply cups in the nursing period (p=.47). 57% of the farms without wet mink kits use drink hangers in the nursing period, whereas 79% of the farms with wet mink kits use the drink hangers (p=.040). Supplement of electrolytes in the water cups are used in 1/3 of the farms (p=.87), and 20 farms add electrolytes to the feed.

Two feed kitchens dominated in the group of mink farms with wet mink kits, but the sample was very unbalanced as to this factor. The amount of feed used to produce a mink skin was around 37 kg, with a tendency of being a little higher in the group of farms with wet mink kits (p=.32).

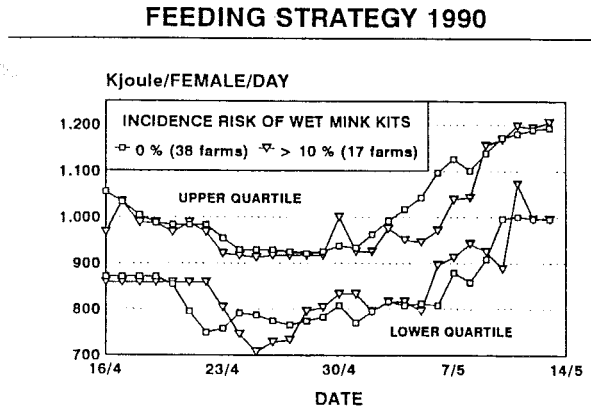

Figure 3. In the last trimester of the pregnancy period the mink farms with high incidence risk (above 10%) undernourish the females to a higher degree and a few days later than the mink farms without wet mink kits

The feeding strategy in the pregnancy period has been evaluated by estimating the upper and lower quartile. This procedure was chosen because of the uncertainty of the reported number of females in the farms. This gives only a rough estimate of the feeding strategy. The mink farms with an incidence risk above 10% have a tendency to administer smaller rations than the mink farms with no wet mink kits (figure 3).

Aleutian disease status was not significantly different in the two groups (p=.36). About half the farms reported problems with nursing sickness (p=.99) with an average incidence risk around 5% (p=.93). Virus enteritis was reported in 22 farms (p=.31) but 1/3 of the farms were vaccinated against virus enteritis, distemper and/or botulism (p=.57) with different vaccine products (p=.62).

12 farms were medicated prophylactically in the feed with antibiotics against wet mink kits. The prophylactic treatment was instituted from mid-April until the end of the nursing period (table 1). The incidence risk of wet mink kits in the prophylactically treated mink farms was not statistically significantly lower than the incidence risk of wet mink kits in the non-prophylactically treated mink farms (p=.10).

Table 1 Prophylactic treatment with antibiotics from mid-April did not reduce the risk for wet mink kits significantly (p=.62)

	Wet mink kits	No wet mink kits	
Antibiotics added	5	7	12
No antibiotics added	57	49	106
	62	56	118

Treatment of wet mink is predominantly done by using antibiotics either as injections to the female or by dropping in the mouth of the mink kit. Additional treatment like new, clean straw bedding, washing the mink kits, or sprinkling potato flour over the kits to dry up the exudate was used in almost all the farms having problems with wet mink kits. 3 farms reported that they reduced the daily feed intake for the females in the period with wet mink kits.

Discussion

In this investigation no distinct factors were identified to explain the outbreak of wet mink kits. The analysis was performed on a farm level. The measurable management parameters and production parameters show practically no significant difference between the two groups.

In this material no information about pathogens involved in the outbreaks was given. Previously Henriksen (2) and Svansson (3) have shown that a broad spectrum of bacteria and vira can be isolated. Normally, wet mink kits respond well to antibiotics, but cases have been reported where antibiotics have had no effect. Whether this phenomenon is due to resistant bacteria or because the outbreak is caused by vira is not known. The syndrome is not contagious in a normal sense. It is possible to transfer wet mink kits into healthy litters without causing an outbreak of wet mink kits in the healthy litters. The opposite is also possible - transfer healthy mink kits into wet mink litters without outbreaks are seen among the transferred healthy kits.

It is surprising that the losses in relation to wet mink kits are so low. The average losses of mink kits did not increase by increased incidence risk of wet mink kits. This must be due to the goal-directed and effective work done by the farmers during an outbreak.

Prophylactic treatment by adding antibiotics to the feedstuff from mid-April to the end of the nursing period has not demonstrated any significant effect. It is therefore not advisable to add antibiotics prophylactically. Unfortunately, the efficiency of the prophylactic treatment is not possible to evaluate as it has been given to the whole farm. To evaluate a possible effect of this treatment several farms should be involved in a controlled experiment where half the sheds will be given prophylactic treatment and the other half of the sheds will not be given prophylactic antibiotics. Complications with resistant bacteriae in the nursing period can only be evaluated by setting up controlled clinical trials like the above-mentioned.

Undoubtedly, there are some identical factors among the farms having problems with wet mink kits. Unfortunately, it was not possible to evaluate all factors in this study. One of the factors that has to be focused on is the feeding strategy in April/May. Farmers have reported that mated females, sold and delivered in the period between 15th and 20th of April did not develop wet mink kits although they had had a massive outbreak on their own farm. Also the opposite situations have been reported: mated females bought mid-April develop wet mink kits like the other females present in the farm, although the farm, from which females originated, had no problems with wet mink kits (4).

The daily feed ration might be a common factor within the farms, but also individual factors like litter size and day of birth are factors to be taken into account. If the feed ration is too low at the end of the pregnancy period, problems in developing the mammary gland could be a result. Møller (5) found that the development of the mammary gland primarily takes place in the last 3 weeks of the pregnancy period.

If the female is fed restrictedly from the 20th of April until delivery (in average around the 5th of May) the female has been restricted a total of 15 days. This means that the female has been undernourished in half of the pregnancy period (calculated in days after the nidation) and 2/3 of the period of which the female is supposed to develop the mammary gland. Whether this causes low content of colostrum for the newborn mink kits, milk of poorer quality, lower milk production in general, or a combination of the above mentioned, is not known.

The nutritional requirements for pregnant females (6) have not yet been estimated which complicates the evaluation of the significance of the undernourishment in the late pregnancy period. The nutritional requirement depends both on the litter size, on the housing system and on the genotype of the female.

Conclusion

Future research in wet mink kits must involve a thorough investigation of all potential factors. The efforts should concentrate on designing observational studies and sampling data from mink farms where the productions are going on and the problems are found. Basic knowledge of the influence of restricted feeding is essential for estimating the undernourishment the females are exposed to in practical mink farming.

Acknowledgement

Data was carefully sampled by Bente Lyngs, The Danish Fur Breeders Association.

References

1 Momberg-Jørgensen. 1952. Pelsdyrsygdomme. (Fur Animal Diseases).

2. Henriksen, P. 1991. Oversigt over "fedtede hvalpe" hos mink. Møderapport. (Review of wet mink kits. Meeting report).

3. Svansson, V. 1991. Studie af en række virusbetingede infektioner hos mink. Licentiatafhandling. (Studies of infections caused by vira with mink. Ph.D.-thesis).

4. Forsøgsfarm Vest. 1991. Upubliceret medd. (Unpublished communication).

5. Møller, S. 1992. Mælkekirtlens udvikling hos mink. Bilag til Statens Husdyrbrugsforsøgs Årsmøde. (Development of the mammary gland of the mink. Annual report for The National Institute of Animal Science).

6. Hansen, N.E., Finne, L., Skrede, A., Tauson, A. 1991. Energiforsyningen hos mink og ræv. NJF-rapport nr. 63. (Nutritional requirement for mink anf fox. Nordic Agricultural Science Report).

The report was presented at the XVII Nordic Veterinary Congress in Reykjavik, July 1994.

Infectious diseases of multiple aetiology in rabbits, mink, foxes and other furbearing animals

Doris Etzel

Domesticated small animals are animals which are used in the production of food and equipment by humans. Farm-bred fur bearing animals as well as meat and angora wool rabbits can be classified as domesticated small animals. This thesis concerns rabbits (*Oryctolagus cuniculus*), chinchillas (*Chinchilla velligera, Chinchilla boliviana*), swamp beaver (*Myocastor coypus*), mink (*Mustela vison*) and foxes (*Alopex lagopus* and *Vulpes vulpes*). European polecat (*Mustela putorius*), raccoon dog (*Nyctereutes procyonides*) and sable (*Martes zibellina*), are also mentioned because they are members of the group of fur bearing animals.
The first part of the thesis describes different types of housing systems and their inherent problems in hygiene and infectiology to outline the development of infectious factorial diseases. Adequate measures of hygiene, approved and developing means of prophylaxis and therapy are described and critically analyzed.

In the second part the infectious factorial diseases of the different species of small domestic animals are described according to organic systems. In every infectious factorial disease etiology, epidemiology, pathogenesis, clinical symptoms, diagnosis and therapy are shown separately.
The infectious factorial diseases of domesticated small animals have more influence on breeding, housing and mating as well as on the economical handling of the products than monocausal infectious diseases. For them there are no standard and approved methods of therapy and prophylaxis. Each of the different methods used until now is noted separately and has been analyzed. Dfferent methods of elimination of the infectious factorial diseases of small domesticated animals have been analyzed providing an overall view.

Aus dem Institut für Medizinische Mikrobiologie, Infektions- und Seuchenmedizin der Tierärztlichen Fakultät der Ludwig-Maximilians-Universität München, Germany. Thesis, 203 pp. 32 tables, 17 figs., 217 refs. In GERM, SU. ENGL. Author's summary.

An introduction to chinchillas

Carol J. Merry

Chinchillas have become animals that veterinarians and technicians can expect to encounter. The ranch-raised fur market, the pet industry, and research institutions recognize that chinchillas are valuable and desirable. Veterinarians and technicians therefore can benefit from a familiarity with the basic characteristics, husbandry, and medical management of these animals. Such information, which is given in this introduction, is particularly useful to veterinary personnel in private pet practices and research laboratories.

Veterinary Technician 11, 5, pp 315-322, 1990. 3 tables, 6 figs., 18 refs. Abs: G. Jørgensen.

Isolation of mycoplasmas from the fox (*Vulpes vulpes*)

D. Chiocco, F. Bertani

Results of research of mycoplasmas from 21 wild foxes (*Vulpes vulpes*) are reported. Oropharyngeal, tracheal, conjunctival and genital tract swabs and also sections of lung have been used for the isolation.

Five strains of mycoplasmas have been isolated from 3 foxes. The strains have been isolated from oropharynx, trachea, conjunctiva and vagina.

By biochemical, serological (Immunofluorescence test) and electrophoretic protein patterns tests, the isolated strains have been identified as *Mycoplasma canis*.

Acta Med. Vet. 37, pp 135-138, 1991. 2 tables, 12 refs. In ITAL, Su. ENGL. Authors' summary.

Trichophytosis of nutria (*Myocastor coypus*) and possible use of vaccines

V. Alyassino, J. Schultz, U. Tornow

Trichophytosis may be a major cause of economic loss on fur farms. Up to ten percent of all furs of affected nutrias may be impaired in

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quality. As in other parts of the world, the dermatophyte Trichophyton mentagrophytes has so far been the only pathogen isolated. Clinically affected and intact animals as well as fungal skin and hair particles ejected by affected nutrias and embedded in cage dirt were found to be the most common sources of pathogens. Humoral immunity has been recordable from survivors of trichophytosis. "Mantavak", a vaccine from the USSR, provided sufficient protection only for small stocking numbers and under favourable hygiene conditions. Failure on a large fur farm was causatively attributed to clearly established high bacterial infection pressure and resulting immunosuppressive effects. Vaccine effectiveness might have been influenced also by differences between dermatophytic strains used in the manufacture of the above vaccines, on the one hand, and local strains, on the other.

Monatshefte für Veterinärmedizin 45, 19/20, pp 717-719, 1990. 2 tables, 11 refs. In GERM. Su. ENGL. Authors' summary.

Myocastor coypus (*Rodentia capromyidae*) as a wild reservoir of Fasciola hepatica (*Linneu*, 1758)

I.C.S. Santos, C.J. Scaini, L.A.F. Rodriques

In an area showing a historical incidence of *Fasciola hepatica* in cattle, 103 *Myocastor coypus* were captured from August 1989 to July 1991. *F. hepatica* specimens were found in the liver of five *M. coypus* (4.85%). Three of these animals were young, about 4 months old, weighing only 2-3 kg. Low egg counts of *F. hepatica* were detected monthly in cattle feces examinations conducted in the area. This was attributed to the intensive administration of liver fluke remedies which were given to the local herds. The problem of fasciolosis was also confirmed by the number of livers condemned in the local abbatoirs, because of lesions caused by that trematode. Although the percentage of *M. coypus* harbouring *F. hepatica* was small, the opportunities for pasture contamination with fasciola infected feces are apparently larger than those from cattle. *M. coypus* usually delivers its feces in the water or in marshy areas, which makes the perfect habitat for the development of the life cycle of *F. hepatica.*

Revista Brasileira de Parasitologia Veterinaria (Brazil), Vol. 1 (1), pp 27-30, 1992. 3 tables, 1 fig., 11 refs. In PORT, Su. ENGL. Authors' summary.

Bilaterally symmetric alopecia associated with an adrenocortical adenoma in a pet ferret

Danny W. Scott, H. Jay Harvey, Amy E. Yeager

Bilaterally symmetrical alopecia in association with an adrenocortical adenoma was diagnosed in a 5-year-old, spayed female ferret. The only other clinical abnormality was vulvar enlargement. Hematologic, serum biochemical, urologic, and basal serum cortisol values were all within normal limits. Ultrasonography revealed a mass in the area of the right adrenal gland. Surgical removal of the right adrenal gland resulted in complete recovery. Histologic examination of the excised adrenal gland revealed an adrenocortical adenoma.

Veterinary Dermatology, Vol. 2, No. 3/4, pp 165-170, 1991. 1 table, 8 figs., 23 refs. Authors' abstract.

The experimental infection of sables with the carnivorous plague virus

S.V. Aulova, Ye.I. Marasinskaya, N.M. Chaplygina

Clinically healthy sables, were submitted to a laboratory challenge with CPV. The virus was shown by presence of the viral genome and antigen in the animal brain and spleen. The question about virus isolation from the sable and it pathogenecity require additional study.

Veterinariya (Russian Federation), no. 2, pp 33-34, 1991. 13 refs. In RUSS, Su. ENGL. Authors' summary.

Topographical analysis of the G virion of Aleutian mink disease parvovirus with monoclonal antibodies

D.L. Barnard, F.B. Johnson

The topography of the Aleutian mink disease parvovirus (ADV) G virion was analyzed with monoclonal antibodies and polyclonal antiserum. There was a homology between the two major structural proteins as others have previously reported. Trypsin treatment of the virion with subsequent immunoblotting revealed that VP2 represents the main peptide on the exterior of virion and that VP1 is probably embedded within the capsid. Additional analyses of the trypsin-treated virions showed that VP2 is responsible for binding complement and that it also represents the structural part of the virion that binds to cellular receptors. A third protein, p34, was detected that might represent a third structural polypeptide because of its many unique epitopes relative to the other peptides detected.

Arch Virol 127, pp 271-289, 1992. 6 tables, 3 figs., 41 refs. Authors' summary.

Parasitological and immunological methods for the detection of *Echinococcus multilocularis* in foxes

J. Eckert, P. Deplazes, D. Ewald, B. Gottstein

This paper reviews parasitological and immunological techniques for the detection of *Echinococcus multilocularis* in foxes.

For the detection of *E. multilocularis* in the small intestine of foxes at necropsy the smear technique, using 15 mucosal smears from different locations of the intestine, with subsequent stereomicroscopical examination of the smears is sufficiently effective. In order to minimize the infection risk for the examiner, foxes are deep-frozen at -80°C for one week prior to necropsy as eggs of *Echinococcus multilocularis* are most likely killed under these conditions. This could be confirmed by own observations.

In 1988/89 and 1990 two groups of 106 and 382 foxes (Swiss Cantons of Zürich and Thurgau) were examined using the smear technique; 14.0 and 39.8% were infected with *E. multilocularis*, respectively.

An ELISA using the sensitive and highly species-specific *E. multilocularis* 2-antigen (Em2-antigen) was applied for antibody detection in body fluids (serum or fluid from the pleural cavity) while 98 cestode-free foxes from Norwegian fox farms did not contain antibodies against Em2-antigen, 59.6%, 38.8% and 12.2% of foxes from endemic areas in Germany, Switzerland and Austria were antibody-positive. These sero-prevalences were related to prevalences of *E. multilocularis* of 54.9%, 14.1% and 3.6% in the same fox populations. The Em2-ELISA is unreliable for the diagnosis of *E. multilocularis* in individual animals but it appears suitable for large-scale pre-screening of fox populations. As further techniques of potential value for the diagnosis of *E. multilocularis* in foxes, copor-antigen detection by ELISA and the identification of parasite DNA by the Polymerase Chain Reaction are discussed. These techniques have already been successfully applied by our group for the diagnosis of *Taenia* infections in dogs and man.

Mitt. Österr. Ges. Tropenmed. Parasitol. 13, pp 25-30, 1991. In GERM, Su. ENGL. 1 table, 10 refs. Authors' summary.

Outbreaks of coccidiosis on two small arctic fox (*Alopex lagopus*) farms

M. Krilic, D. Hlubna, A. Jazic

In July, 1988, a disease characterized by a haemorrhagic diarrhoea appeared in young arctic foxes (3-4 months of age) on 2 farms in the Sarajevo area. Death occurred in 67 (100%) of those affected on 1 farm and 37 (86%) on the other. Once the causal agent (Isospora canivelocis (canis?)) was identified, the addition of sulfamonomethoxine to the drinking water was an effective treatment.

Veterinaria (Sarajevo), 39, 3-4, pp 487-489, 1990. 1 fig., 5 refs. In SERB. CAB-abstract.

Studies on the aetiology of enzootic pneumonia in nutria (*Myocastor coypus*)

P.E. Martino, N.O. Stanchi

This disease is mainly reported in autumn and winter in 1- to 3-week-old animals on fur farms

in Argentina and northern Italy. The symptoms and lesions are described. Bacteriological examination of affected lungs resulted in the isolation of Streptococcus zooepidemicus from almost all cases, often in pure culture but sometimes associated with other bacteria, including Staphylococcus aureus, Pasteurella multocida, Salmonella typhimurium, and Escherichia coli.

Acta Medica Veterinaria 37, 2, pp 113-116, 1991. 8 refs. In ITAL, Su. ENGL. CAB-abstract.

Experimental oral administration of canine adenovirus (type 2) to raccoons (*Procyon lotor*)

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

Canine adenovirus type 2 (CAV2) has been proposed for recombinant vaccines to control rabies in wild animals. To evaluate the suitability of CAV2 as a safe vector for the genetically engineered vaccines, seven wild-caught raccoons (three males and four females) were administered CAV2 per os. Two of the animals were euthanatized on each of post-infection days 3, 6, and 14, and one was euthanatized on day 21. Two other control raccons (a male and a female) were also euthanatized on day 21. Microscopic pulmonary lesions of multifocal necrotizing bronchiolitis with basophilic intranuclear inclusions were seen in 3/4 raccoons euthanatized on post-infection days 3 and 6. Ultrastrucural examination of lungs with pulmonary lesions revealed hexagonal viral particles characteristic of adenoviruses. CAV2 is potentially pathogenic for raccoons, and this susceptibility should be of concern to developers of recombinant vaccines who intend to use CAV2 as a vaccine vector.

Vet Pathol 29, pp 509-513, 1992. 1 table, 3 figs., 21 refs. Authors' abstract.

Clinical immune efficiency of inactivated vaccines from serum-free cell cultures of mink enteritis virus (MEV)

D.L. Zhang

All the mink over 5 weeks of age, whether healthy without MEV, sheltering MEV or with typical mink virus enteritis (MVE) clinical symptoms, could be inoculated with inactivated vaccines with mineral oil or Al $(OH)_3$ gel adjuvant from serum-free cell cultures of MEV. It was the optimum programmed vaccination that each mink was injected with 1 ml of the vaccine by S.C. or I.M.. More than 70,000 doses of the mineral oil adjuvant MEV vaccine and more than 7,000,000 doses of the Al $(OH)_3$ gel adjuvant MEV vaccine had been inoculated into mink, raccoon dogs and foxes on fur ranches heavily affected with parvovirus enteritis since 1986. The clinical investigation on the field prevention and emergency control of MVE showed that both vaccines with different adjuvants had the same immune efficiency, and the MEV vaccines with different titre (HA 64^{*} - 8192^{*} or $TCID_{50}$ $Log_{10}^{7.8-9.7}$) had the duration of the immune immerse period 3-10 days, the length of the immune protective period not less than 6-12 months, the duration of the preservation period not less than 6-9 months and the immune protective rate 100% ($P<0.01$). The serum HI antibody mean titre of HA 64^{*} or $TCID_{50}$ $Log_{10}^{7.6}$ was about 32^{*}, and the MEV vaccines with the quality criteria had the duration of the immune immerse period 7-10 days, the length of the immune protective period 12 months, the duration of the preservation period at 2-8°C 9 months and the immune protective rate 100%.

Acta Veterinaria et Zootechnica Sinica 22, 4, pp 361-364, 1991. 3 refs. In CHIN, Su. ENGL. Authors' summary.

Case report of a wild raccoon that died of canine distemper

Masanori Kubo

A dead wild raccoon dog was examined pathologically. Gross hepatization of the lungs was seen. Histologically, eosinophilic cytoplasmic inclusion bodies were found in the cytoplasm of plenic reticuloendothelial cells, surface epithelial cells of the stomach, transitional epithelial cells of the bladder, and the bronchiolar epithelial cells. Electron microscopically, crystalline-arrayed nucleocapsids were observed in the spleenic reticuloendothelial cells and transitional epithelial cells of the bladder. From these find-

ings, the death of the raccoon dog may be attributed to the growth of canine distemper virus in the cells of the lungs, spleen, stomach, bladder and bronchia.

J. Jpn. Vet. Med. Assoc. 44, pp 230-233, 1991. 8 figs., 11 refs. Authors' summary.

Dermatophytosis in chinchilla (*Chinchilla lanigera*, Standard) due to *Microsporum gypseum*: first case described in Brazil

L. Ferreriro, M. Costa, R. Gutierrez

Ringworm infection in chinchilla (*Chinchilla lanigera*, Standard) by *Microsporum gypseum*. The first case described in Brasil. This is the first report of *Microsporum gypseum* infection in chinchilla in Brasil, with comments about the originality of the case and its implications. It also presents a literature review on the occurrence of dermatophytosis caused by the same agent in other animal species in Brasil.

Arquivos-Faculdade de Veterinaria, UFRGS, 17, pp 77-80, 1989. 11 reffs. In PORT, Su. ENGL. Authors' abstract.

A serologic survey of the island fox (*Urocyon littoralis*) on the Channel Island, California

David K. Garcelon, Robert K. Wayne, Ben J. Gonzales

The island fox is listed as a threatened species in California. A serologic survey of 194 island foxes (*Urocyon littoralis*) was conducted over the entire range of the species on the Channel Islands (California, USA). Antibody prevalence against canine adenovirus and canine parvovirus reached 97% and 59%, respectively, in some populations sampled. Antibody prevalence against canine distemper virus were not detected.

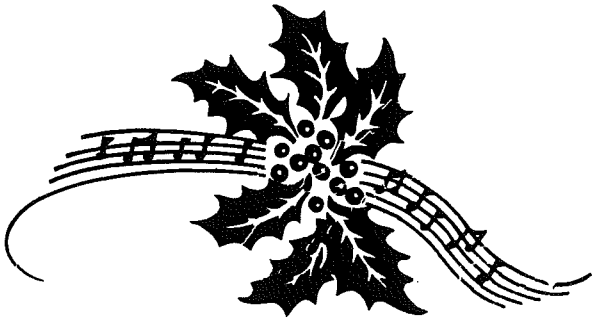
Journal of Wildlife Diseases, 28 (2), pp 223-229, 1992. 1 table, 49 refs. Authors' abstract.

Hemoparasites of raccoons (*Procyon lotor*) in Florida

Sam R. Telford, Donald J. Forrester

Four hemoparasite species (*Babesia lotori, Trypanosoma cruzi, Dirofilaria tenuis* and *Mansonella llewellyni*) were found in raccoons (*Procyon lotor*) collected from 1972 to 1974 in Duval (n=14) and Collier (n=170) counties, Florida (USA). *Trypanosoma cruzi* was found in thin blood smears from one raccoon at each locality. The prevalence of *B. lotori* was 79% and 80% in samples taken in December 1973 in Collier and Duval counties, respectively. No patent infections by *B. lotori* were detected in raccoons collected in Collier County in December 1972, but 42% of the raccoons examined in September 1973 were infected. In Collier County there were no significant differences in the prevalence of *B. lotori* by host sex or age. In Duval County, overall *D. tenuis* prevalence was 7%, wheras that of *M. llewellyni* was 14%; the latter species was not found in Collier County. Adult raccoons had a significantly greater prevalence of *D. tenuis* (32%) than did subadults and juveniles (7%), and male raccoons showed a significantly greater prevalence (51%) than did females (8%).

Journal of Wildlife Diseases, 27 (3), pp 486-490, 1991. 2 tables, 7 figs., 15 refs. Authors' abstract.



The nutrient requirements and nutrient value of feeds for fur animals

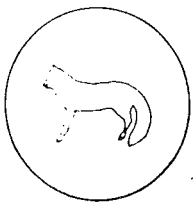
In SLOVAK. language, 60 pp, 61 tables, 36 refs.

POTREBA ŽIVÍN

A VÝŽIVNÁ HODNOTA KRMÍV

PRE KOŽUŠINOVÉ ZVIERATÁ

The Nutrient Requirements and Nutrient Value of Feeds for Fur Animals



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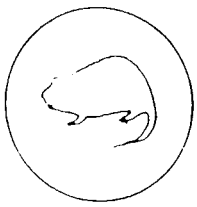

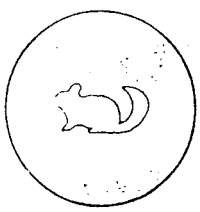

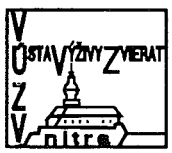

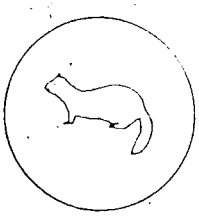

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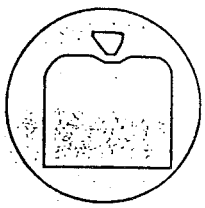

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ECOLOGICAL GENETICS IN MAMMALS

Editors: Günter B. HARTL and Janusz MARKOWSKI

Special volume of Acta Theriologica (Vol. 38, Suppl. 2: 1 - 194, 1993)

The special volume of Acta Theriologica representing the proceedings of the meeting "Ecological Genetics in Mammals – Current Research and Future Perspectives" (held in September 1992 at Łódź, Poland) was published in November 1993.

Papers of this special issue are related to three major topics: (i) the association of genetic diversity with morphological variation and developmental homeostasis, (ii) the various genetic problems associated with the preservation of populations and species, and (iii) the relationship between genetic variation and mating systems and social organization.

CONTENTS: **Genetic variation, morphological variation, and developmental homeostasis:** Morphological asymmetry in mammals: genetics and homeostasis reconsiderated, *J. M. Novak, O. E., Rhodes, Jr, M. H. Smith and R. K. Chesser*; Fluctuating asymmetry as an indicator for differentiation among roe deer *Capreolus capreolus* populations, *J. Markowski*; An integrative analysis of genetic differentiation in the brown hare *Lepus europaeus* based on morphology, allozymes, and mitochondrial DNA, *G. B. Hartl, F. Suchentrunk, K. Nadlinger and R. Willing*; Variability of minor tooth traits and allozymic diversity in brown hare *Lepus europaeus* populations, *F. Suchentrunk*. **Conservation genetics**: Conserving patterns of genetic diversity in endangered mammals by captive breeding, *A. Schreiber, L. Kolter and W. Kaumanns*; Conservation genetics of managed ungulate populations, *K. T. Scribner*; Population genetics of the springbok *Antidorcas marsupialis* – a preliminary study, *R. C. Bigalke, G. B. Hartl, M. P. S. Berry and H. J. Van Hensbergen*; Effects of fragmentation and isolation on genetic variability of the Italian populations of wolf *Canis lupus* and brown bear *Ursus arctos*, *E. Randi*; Depauperated gene pools in *Marmota m. marmota* are caused by an ancient bottle neck: electrophoretic analysis of wild populations from Austria and Switzerland, *M. Preleuthner and W. Pinsker*; Genetic variability of roe deer *Capreolus capreolus* in Italy: electrophoretic survey on populations of different origin, *R. Lorenzini, M. Patalano, M. Apollonio and V. Mazzarone*; Biochemical genetic description of German and Swiss populations of red deer *Cervus elaphus*, *H. Ströhlein, S. Herzog, W. Hecht and A. Herzog*. **Genetic variation, mating systems, and social organization**: Evolution of mammalian social structure, *R. K. Chesser, D. W. Sugg, O. E. Rhodes, Jr, J. M. Novak and M. H. Smith*; Are biochemical-genetic variation and mating systems related in large mammals? *M. Apollonio* and *G. B. Hartl*; Breeding strategies and genetic variation in European roe deer *Capreolus capreolus* populations, *F. Kurt, G. B. Hartl and F. Völk*.

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