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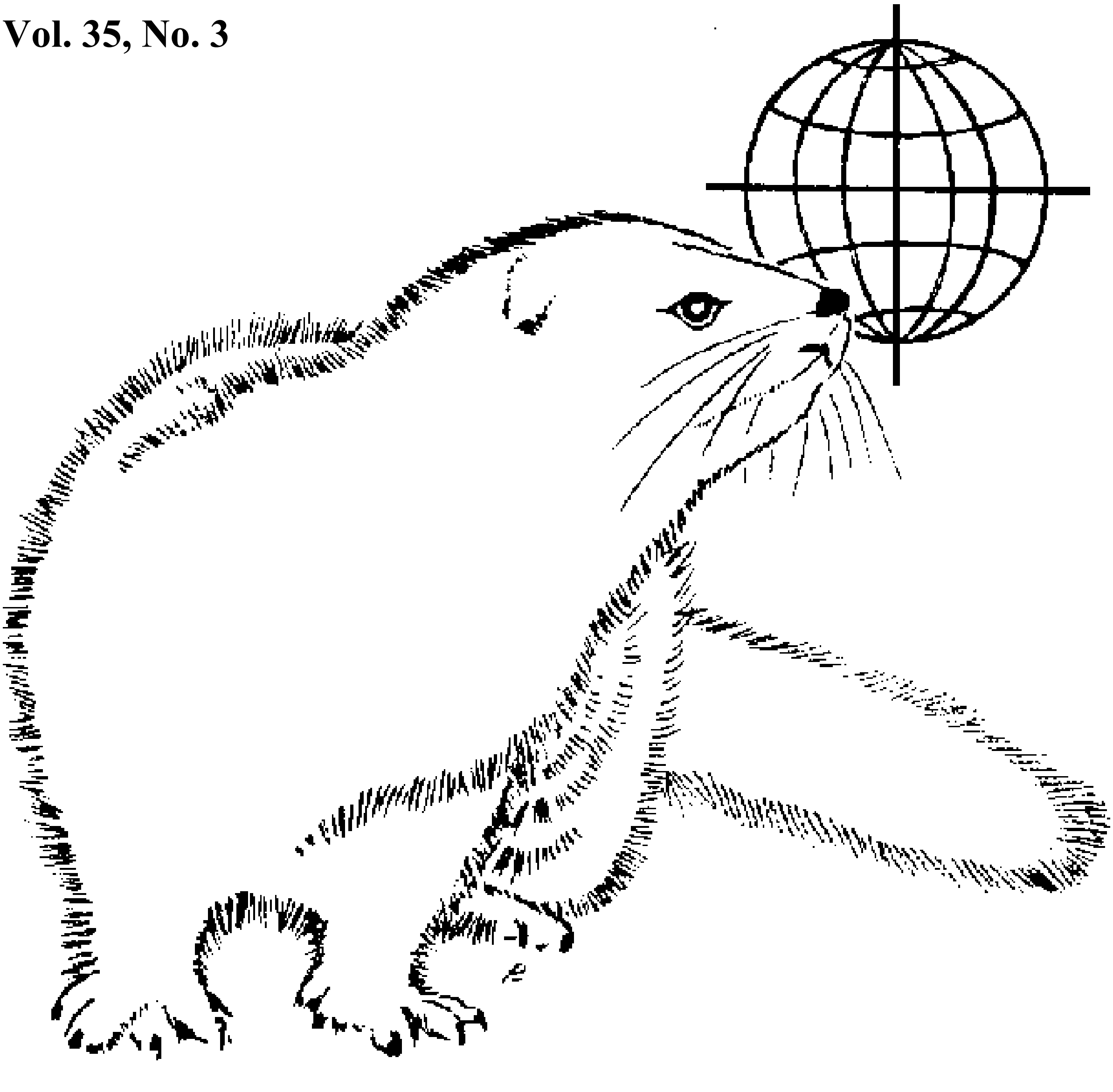

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INTERNATIONAL FUR ANIMAL SCIENTIFIC ASSOCIATION

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Notes from the Editor

Fur animal production and the related industries have increased considerably in China over decades and made China an important actor in the field. This issue of Scientifur 35,3 contains a publication reviewing the development and status of mink farming in China and the need for future efforts to improve the industry.

This issue of Scientifur also presents abstracts from studies dealing with construction of a bacterial artificial chromosome (BAC) library for American mink, chromosome evolution in Canid species including foxes, the effect of inbreeding on fecundity in mink, association between polymorphism in candidate genes for fat accumulation and body and skin weight in foxes, transmission of Aleutian disease virus in mink and pancreatitis in hyperlipemic mink.

Communication of results from fur animal research projects to the fur industry is of outmost importance. This issue brings abstracts from the yearly meeting at Faculty of Science and Technology, Aarhus University in Denmark held this September. It is the aim of the meeting to present the most recent research results to the fur animal industry and to fur animal production advisors.

Vivi Hunnicke Nielsen
Editor Scientifur

A review of mink farming practices in China

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Abstract
Mink are one of the most common and most important fur bearing animals used for production in the world. Top-quality fur products are produced which have great commercial value. China has a large-scale mink fur farming industry. China produced 12 million mink pelts in 2010, representing 23.8% of the world's market. Thus, China is an important international actor in the mink farming industry and the industry is continuously expanding. China is among the world's biggest producers, consumers, importers, and exporters of fur apparel. This review covers the current status and problems in mink farming and industry in China. It also introduces the development of fur trade in China.

Key words: China; farming; fur animals; mink

Introduction
The history of mink farming in China is short compared with that in Europe and North America. Chinese production began in 1956 but significant market demand for fur has really only been present in China since the 1990s (Zhang, ZM, 2005).

World mink production
World mink production varies according to market demand (Figure 1). In 1988, the production was 42 million mink pelts and by 1993 production had fallen to 20 million pelts (Fur Commission USA, 2010). The production rose again to a new high value of 55.8 million in 2007 (Fur Commission USA, 2010). International mink production has stabilized over the last number of years with the 2010 production estimated to be approximately 50.48 million pelts (Fur Commission USA, 2010). Denmark is the leading mink-producing country with nearly 27.7% of world production in 2010 followed by China at 23.8% of the production (Ward, 2010).

Mink production in China
Mink have been farmed for fur in China since 1956 (Zhang, ZM, 2005). Chinese mink farming flourished in the 1990s after China's Reform and Open-Up Policy. The first fur animal breeding farms in China were built in Heilongjiang, Liaoning, and Shandong Provinces (Guo et al., 2006). In addition to traditional state-run farms, private and family run farms were developed. Some foreign investors established even more fur farms during the 1990s.

The major mink farming areas are located in the northern and northeast areas where the climate is ideal and feed supply is abundant. These include Shandong, Liaoning, Hebei, Jilin, Heilongjiang, Jiangsu, and the Inner Mongolian Provinces (Liu, 2008). About 80% of mink are located in Shandong Province (Zhong, 2007), followed by Liaoning Province**.** These provinces have a favorable climate for producing high quality fur and abundant feed is available.

The main fur animal species produced in China are mink, fox and raccoon dog (Wang et al., 2008). The academic experts in the Institute of Special Wild Economic Animals & Plants of China's Academy of Agriculture Science estimated that China produced an approximated 30 to 35 million mink, 15 million foxes and 10 million raccoon dogs in 2009 (Petry & Liting, 2010). Mink production was estimated to be stable at 30 million pelts, while fox production increased to 25 million pelts and raccoon dog production increased to 15 million pelts in 2010 due to the recovery of the fur industry (Petry & Liting, 2010). However, according to statistics undertaken by the Oslo Fur Auctions, Chinese mink production in 2009 dropped to 9 million pelts after peaking in 2006 and increased again to 12 million in 2010, representing 23.8% of the world market (Ward, 2010). China currently ranks second in mink production to Denmark now and continues to grow (Ward, 2010).

Most fur farms in China are family business which makes it difficult to get exact knowledge of the fur production and size of the trade. Chinese fur skins are frequently sold directly to skin dealers or manufacturers rather than at auctions (Gao et al., 2007). They are primarily consumed in the domestic market. The data quoted was collected from mink farms, the Institute of Special Wild Economic Animals & Plants of China's Academy of Agriculture Science and feed mills (Petry & Liting, 2010). There is no official statistical record of fur production and markets share. One method of estimating actual production is to examine the sales of certain vaccines used for fur farm animals. Using this method to predict production suggests that China has become the largest fur producer in the world and China is clearly the largest fur processing center in the world (Petry & Liting, 2010).

China is the leader in production in fox and raccoon dog and the second or probably the largest mink producer in the world (Petry & Liting, 2010). Mink farming is growing quickly in recent years because of the high demand for fur articles by consumers around the world (Liu et al., 2010).

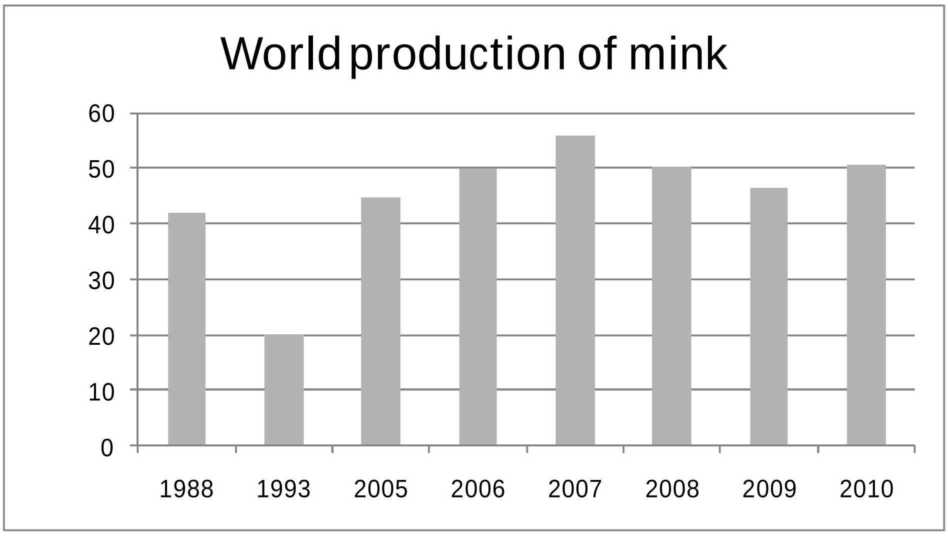

Figure 1. World production of mink. 2009 Information collected by OFA, 2010 Information collected by FFS/KF

Mink species in China

There is a major species of mink used commercially around world namely the American mink (*Neovison vison*). In addition, there are some excellent local strains that were developed after years of cross breeding. A wide range of mink pelt colors exist, including white, a host of shades of brown and gray, some tinged with blue or pink, bearing trade names such as Lavender, Hope, Sapphire, Gun metal (Blue Iris) and Mahogany (Mink farming in the United States, 2010). The most popular pelt is black, so black mink dominates the farms in China (Liu, 2009). There are various local strains of mink produced in different provinces. The main types of mink include Jinzhou-Black-Standard Mink (JBS mink), ordinary black mink and some local mink strains.

JBS mink is a well-known local strain in China and was awarded National Product of Geographical Indication of Mink status in Liaoning Province in September 2010 (Jing & Mei, 2010). It is a highly prized and well-known Chinese strain of mink and was bred for 11 years from 1988 to 1998. It is the top recognized mink brand in China. JBS mink is an outstanding strain of mink that is suitable for farming north of 35 degrees latitude. Its' attributes include good size, dark colored, presence of guard hair and under wool, uniform hair color on the back and belly, no white spots on the chin, heavy and full under wool, good growth, good breeding performance, good adaptability, stable heritable characters (size, colour), fertility, reproductive performance and low kit mortality (Zhang, ZM, 2000). JBS mink is the best of the local mink strains. The average litter size is 6.23 kits and survival rate of kits is over 65% at the end of June (Zhang ZM, 2000). In addition, JBS mink perform better than the American mink strains in China.

Scale of farming

There are five categories of mink farms in China (Table 1). There are fewer than 10 extra large mink farms (over 10,000 breeding stock) in China and these have 5% of the total domestic mink production. Approximately 5% of farms are large farms (5,000-10,000 breeding stock) which represent 10% of the total domestic production, 15% are medium size farms (1,000-5,000 breeding stock) which represent 20% of the mink production and 20% are small farms (200-1,000 breeding stock) which represent 25% of the total domestic production. Most Chinese fur farms are family business, which are often operated by one or two generations of the same family (Ren, 2009). Approximately 60% of all farms are family-owned farms (less than 200 breeding stock) which represent 40% of the total national production.

Most Chinese fur farms were built during the past fifteen years (Hsieh-Yi et al., 2005). After a decade of development, family business and small fur farms account for 60% of China's farming operations (Ren, 2009). These developed from a few dozen animals to thousands of fur animals. Most farms produce mainly mink, but some farms also produce other species of fur including Arctic fox, blue fox, Wusuli raccoon dog, and Standard Rex Rabbit (Zhang, ZX, 2005).

Some large ranches have been established as the result of overseas investments. Family-owned fur farms are often run as family business. Small and medium scale farms hire 5 to 25 employees, while larger farms employ from 50 to several hundred employees.

Almost all mink farmers begin the business without having gained a college or university degree in agriculture, biology or business. They often participate in the management of the family farm as children and continue as adults. This is different from Denmark, North America and some other fur farming countries. Chinese farmers prefer to learn through practical experience.

Table 1. The size and proportion of scale of mink farms in China

	Extra large (over 10,000)	Large (5,000-10,000)	Medium (1,000-5,000)	Small (200-1,000)	Family-owned (less than 200)
Total farm	<10	5%	15%	20%	60%
Total farm	5%	10%	20%	25%	40%

Feed and feeding

China's fur animal feeds are made with fresh and dry feed (Liu, 2008). Fresh feed ingredients include fish, poultry and poultry by-products (head, bones, and offal), extruded corn, vegetables, and premix feed (Zhang, ZM, 2001). Dry feed consists of fish meal, meat and bone meal, feather meal, extruded corn, and extruded soybeans **(**Li et al., 2006**).** Fresh/wet feed is often mixed on farm, while dry feed is processed by feed mills. In Heilongjiang Province, about 60% of fur farms use commercially produced feed to increase feed efficiency and provide adequate proper nutrition for the various stages of reproduction, lactation, growth and fur production (Pu, 2011).

By nature, mink is a carnivore and as such requires an animal protein based diet (Rouvinen-Watt et al., 2005). Mink are often fed a complete fresh/wet diet which meets their nutrient requirements. A balanced diet includes the fresh ingredients listed above and cereal, vitamins and minerals. The farmers prepare the wet feed and add the vitamin-mineral premix obtained from commercial mink feed manufacturers. Chinese mink farmers typically prepare the feed by themselves using western fur animal feed formulas (Danish or North American). Necessary (appropriate) animal and plant protein are added at the different stages of mink growth to achieve fur quality similar to the imported pelt quality. This is different from Denmark, North America, and the other countries in which feed is most often prepared in central feed kitchens or on farm. But China is a vast territory and the ingredients vary in the different regional areas. Therefore, the ingredients and quality in the diet can differ greatly.

Chinese fur farms are generally small in size, lacking modern technology and management because they are mainly family business (Petry & Liting, 2010). Due to increased feed costs, producers have begun to adjust the traditional trash (industrial) fish-based diet. This diet has resulted in poor nutrition, including deficiencies of protein, fat, and necessary amino acids. These poor rations have resulted in smaller pelts and inferior quality compared to internationally produced skins. This is a significant competitive disadvantage. Some small fur farms went out of business under the market pressures in 2008 and 2009, while large scale farms maintained their market share.

Mink farming production cycle

It takes only one year for a complete cycle of breeding, gestation, birth, weaning, growing, furring and the harvesting of the fur. Mink are typically bred in March in China (Zhang, ZM, 2001). In general, one male mink is mated with 4 females (Zhang ZM, 2005). There is much variation in the length of the breeding season in different provinces with different latitudes, such as Liaoning, Heilongjiang, Shandong, and Hebei Province (Zhang, ZM, 2005). The breeding season for mink occurs in the period from late February to approximately March 21 (Sun & Xu, 2010). Gestation typically is 40 to 55 days for JBS mink, 47 days is average. But this period varies from 37 to 81 days, as implantation of the fertilized egg can be delayed for 1-47 days (Zhang, ZM, 2001). Mink give birth from the middle of April to approximately May 20. Most kits are born from April 25 to May 5 (Zhang, ZM, 2001). Litters range in size from 1 to 18 kits, but 5 to 8 are the average (Er, 2011). The kits are weaned at 40 to 45 days of age. They are vaccinated against distemper, enteritis at weaning, and *clostridium botulinum* two or three weeks later, and hemorrhagic pneumonia in August (Wu et al., 1992).

Distemper is wide spread on fur farms. The mortality rates of distemper are much higher in fox and raccoon dog than in mink. Mink enteritis virus and *clostridium botulinum* (food poisoning) are also common. Epidemic diarrhea associated with poor quality feed ingredients is wide spread in recent years (Luo et al., 2008). Aleutian Disease outbreaks have affected some mink farms. These farms experience loss of production, increased mortality and poorer fur quality. Aleutian Disease is a disaster for affected farms and there is no vaccine or cure now. A significant number of fur farms are affected by nutritional metabolic disease and parasites (Li, 2011; Gu & Feng, 2010).

The animals shed their fur gradually during the late summer to early fall and then produce the winter fur. Mink are then pelted with fully prime fur in mid-November to early December. Euthanasia of mink is done using carbon monoxide or carbon dioxide (Feng et al., 2007). The best animals are selected for breeding and kept for the next breeding season, ensuring that the quality of the farmer's stock keeps improving. The pelts are sold and the herd grows in the farm during the following calendar year.

Production management in mink farming

Mink have been farmed for fur in the United States since the 1860s and in Denmark for more than 80 years (Mink farming in the United States, 2010; Sun et al., 2006). There are only 55 years of mink farming history in China. In the earliest years, there were two small bowls with food and fresh water in the cage. The food looked like the non-sticky porridge. The workers cleaned the bowls every day to keep them clean. But this method required a lot of work and was labor-intensive. As Chinese mink farming developed, farmers have gained much knowledge and experience from Denmark, Canada and the United States. Currently, most farmers have changed the way to feed mink from the top front of the cage (Fur Trade Web, 2009). Automatic watering equipment is common on Chinese farms ensuring that mink have free access to water all the time.

Some middle-sized (over 2000 mink) and large farms use the more efficient mink feed cart. One worker can feed 750 female breeders by using a feed cart. These advances in management ensure that mink have fresh feed and water, and it also saves much labor. Feed is given once daily in winter and twice daily the remainder of the year.

Unlike North America, China doesn't have a specific association to organize and teach farmers how to operate and manage mink farms. Chinese fur farmers must have expertise in every aspect of the family business. They must design the farm; build the buildings and cages; purchase breeding stock and feed ingredients; create a ration; provide good animal health, and process the pelts after harvest (Petry & Liting, 2010). Feed is usually processed by farmers themselves. A few large fur farming corporations are vertically integrated. They are capable of managing all aspects of fur farming (breeding, growth phases, slaughter, pelt processing etc.) as well as dressing pelts and fur manufacturing.

Most of the cages holding breeding mink have the dimensions of 90 cm (D) × 30 cm (W) × 45 cm (H) and mink for pelts live in cages with 60 cm (D) × 30 cm (W) × 45 cm (H) with a 25 cm (D) × 32 cm (W) × 45 cm (H) nesting wooden box inside (Tong & Tan, 2007). They also have access to fresh water by an automatic water nipple. Mink are housed in standard cages which are suspended above ground over 45 cm high in the unheated shed.

Industry management

The growing global demand for fur has led to the development of extensive fur farming in China. Mink associations and fur institutes are needed in order to improve the development of fur faming. The Chinese farmers are learning from Denmark and North America. Some large farm owners even visit Denmark and North America to learn or may hire experienced consultants from Denmark to help them to manage their farms.

Fur animal welfare

At the infancy of fur farming in China, living conditions for mink were poor because the farmers were inexperienced and had insufficient knowledge. These unfavorable conditions caused mink stress and disease and injuries were widespread. Stress is a factor causing undesirable behavior that includes self mutilation, reduced reproduction, killing of young by nursing females, and other negative behavior (Hsieh-Yi et al., 2007). Nervousness or fear is a sign of stress. Their poor welfare could affect growth, fur quality and consequently reduce the farmer's income (Sun & Li, 2008).

Mink farmers have continued to learn and have become more experienced after years of farming. Currently, more and more farmers are getting to know the importance of welfare. Farmers who do not notice the animals' welfare may suffer lower financial returns. They are beginning to realize that they should manage the mink farming in a scientific way. Fur quality is also an indicator on whether animals are well cared for. Optimal living conditions for the farmed animals can improve health, growth and reproduction of mink (Zhao & Ding, 2004).

Chinese fur farmers are improving living conditions, providing good nutrition, comfortable housing, prompt veterinary care, better management, correct euthanasia, and improved animal welfare. All of these improvements make mink very comfortable in their farm environment. Currently, housing conditions, husbandry, transport, and slaughter practices are improving to international fur industry levels. The fur animals are treated humanely. These conform to the fur welfare of the International Fur Trade Federation (International Fur Trade Federation web). China currently has no laws governing fur animal welfare unlike other countries (Hsieh-Yi et al., 2007). Although there is no legislation for animal welfare, the Chinese government has introduced standards that promote and enforce humane treatment and slaughter of fur farm animals (China Fur Commission of China Leather Association, 2005). The killing methods for animals on fur farms generally refer to methods such as gassing, lethal injection and electrocution (European Commission, 2001).

Scientific research on fur animal welfare is seldom done in China, but scientists, farmers, and government are beginning to realize the importance of animal welfare. There will be more scientists focusing on the research of fur animal nutrition, disease and welfare in the future.

Fur trade in China

Sale by auction is the principal way of selling fur internationally (Steller, 2004). The world's large fur auction houses are the Kopenhagen Fur Centre, Finnish Fur Sales in Helsinki, the North American Fur Auctions in Toronto, American Legend Cooperative in Seattle and Sojuzpushnina in St. Petersburg (Gao et al., 2007). The auctions protect the interests of farmers and increase competition in the market place. There is no international fur auction in China. Most of Chinese ranchers sell fur privately or on the free market (Gao et al., 2007). A professional fur auction house is needed to guarantee profits for the Chinese farmers and it can also help them improve fur quality and meet international standard.

China is a member of the International Fur Trade Federation, the biggest fur trade association in the world. China’s fur imports are mainly high quality raw mink and fox skins. They were valued at US $463 million in 2009. Its major fur exports are garments and processed fur products (Petry & Liting, 2010). The value of fur product exports in 2009 was US $1.3 billion and expanded in 2010 due to the increases in fur market prices and overall economy recovery (Petry & Liting, 2010). International fur companies have moved their business increasingly to China. These fur traders, processors, manufacturers, and fashion designers have found an environment (cheap labor and less regulations) conducive to higher profits (Hsieh-Yi et al., 2007).

China fur market

Over the last few decades, China has become an important producer, consumer, and source of fur articles in the world (Ward, 2010). More than 95% of Chinese manufactured fur garments are exported to Europe, USA, Japan, Korea and Russia. Hong Kong’s exports to Europe, USA and Japan have reached 80% of production (Hsieh-Yi et al., 2007). China’s exports of fur and related products for 2009 were about US $1.3 billion (Petry & Liting, 2010). China is the largest supplier of fur garments to the USA (Petry & Liting, 2010).

The main imports of fur and products into China are raw materials, which account for 97.5% of the value (Petry & Liting, 2010). Scandinavia is the biggest fur animal production region in the world and also the main origin of China’s fur material imports (Petry & Liting, 2010). Imports of raw fur skins have increased in the last decade (Petry & Liting, 2010). The value of these items have increased from US $165 million in 2000 to US $463 million in 2009, an increase of 180% (Petry & Liting, 2010). Many of these pelts are dyed in China before being re-exported as fashionably colored fur trimmings (Hsieh-Yi et al., 2007). Haining, in Zhejiang Province is the biggest fur market (Guo et al., 2006). China has become the centre among the fur industry trade countries and the leading manufacturer of fur goods. The Chinese market has become the foundation for world trade in furs. There are now seven important fur markets in China, each with different unique features, according to the division of labor (Zhang, ZL, 2005). These markets are ready to compete in all aspects of the global fur trade. In 2008 China imported US $7.4 million worth of fur apparel from the USA. In 2009, number had dropped to just US $1.6 million (Ward, 2010).

In 1979 the Hong Kong Fur Federation was formed to organize and develop the fur trades interests. Now the organization has 150 members representing most of the fur trade in Hong Kong (Hong Kong Fur Federation web). The fur industry of Hong Kong is expanding at an incredible rate. Today, mainland China and Hong Kong have become an important production base. According to a United States Department of Agriculture report, Hong Kong is now the leading fur manufacturing and trade centre in the world, handling 70% of the trade in raw furs and 80% of the world's processed furs (Lam, 2011). The mainland's fur processing industry became the largest in the world in just 10 years according to the US Department of Agriculture's Global Agriculture Information Network report, issued last year (Lam, 2011).

Beijing is the home of the China Fur & Leather Products Fair. This annual event has become an increasingly important part of the international fur trade as well as an important export trade vehicle for China (China Fur & Leather Products Fair, 2011a). Its international importance is reflected in increased participation and attendance. The China Fur & Leather Products Fair now ranks as one of the most important fur fairs in the world (China Fur & Leather Products Fair, 2011b).

Why China is becoming a world leader in the fur industry

China has become an important actor in fur farming production and processing. China will also become the largest consumer center. The potential fur market in China is tremendous and the future prospects are very promising. Six factors make China the principal fur industry leader in the world, as discussed below.

1. Large scale production of fur animals and cheap labor
China is the largest fur farming country in the world and estimated to produce 70 million fur animal in 2010 (Petry & Liting, 2010). Fur farming is developing rapidly because of cheap labor and abundant feed in China.

2. Further processing of fur products
Since China's Reform and Open-Up Policy in 1978, the fur trading markets have emerged across China. Haining City, in Zhejiang Province, is the China Fur & Leather Capital, with the largest production base in China (Guo et al., 2006). It is also one of the most important leather producing-processing centers in the world. It is a modern fur garment-producing city with design, development, research, production, and sales all in one. The total value of the industrial output has reached US $2.022 billion and as the key market in Chinese leather markets, the amount of trade in Haining China Leather Market was US $928.7 million. Haining has become one of the largest fur markets in China, with more than 100 thousand fur pelts traded daily - raw materials markets (Zhao & Ding, 2004). The Haining China Leather Market imports approximately 25% of the world’s total fur (Xu, 2007). This makes China an important market.

3. Abundant fur processing ability
Many famous fur production factories are still located in the traditional fur industry centers of the developed countries, such as the United States, Canada, Greece, France, Germany, Austria, and Italy as well as those in Northern Europe. However, increasingly, famous fur products are also being made in mainland China and Hong Kong. China has caught up and leapt forward to be first in the world.

4. The leading fur trade center in the world
According to China Leather Industry Association statistic, Chinese fur exports were US $1.98 billion and imports were US $250 million in 2010, which represented the increase of 52.4% and 24.1% respectively over the previous year in 2009 (Zhang, 2011). Imports of mink pelts totaled 5 million and fox pelts 1.5 million in China annually, which was 40% of the fur auction in the world (Zhao & Ding, 2004).
The fur industry is based on an enormous Chinese domestic consumption. In the past, fur garments were synonymous with luxury, but now fur clothing is gradually becoming more common for more people. This reflects the new change in fur consumption in China.

China is currently the world's largest consumer of furs. The demand for fur products in China has put upward pressure on world fur prices. The Chinese consumer demand for fur appears to be in excess of fur production, which guarantees that prices will remain high (Westwood, 2001).

5. The largest fur garment export business in the world - Hong Kong
The traditional fur garment world market has been located mainly in North America, Russia and the European countries, but in recent years the market has expanded rapidly to Japan, South Korea, and China (Hui Dian Market Reports, 2008). Because of the special status of Hong Kong, it has become the major region for fur trading in the world. At present, Hong Kong mainly exports fur to South Korea, Japan, the United States, Canada, Italy, Spain, Russia, and mainland China (Hui Dian Market Reports, 2008). Hong Kong is the leader in the export of fur garments in the world.

6. Globalization of the Chinese fur industry
At present, the main fur animals in China are mink, fox, raccoon dogs, and Rex rabbit (Guo et al., 2006). China is becoming stronger in the fur business and it will eventually dominate as the market matures. While the fur garment has traditionally been the center of fashion in the world, fur designers are now providing novelties and new styles to strengthen and revitalize fur fashion. North American Fur Auctions and Kopenhagen Fur Auction have begun to train and teach some young and excellent Chinese designers in their design studios.

China’s fur industry improvement
Chinese fur farming has progressed greatly in only 55 years, but there are still many problems in the fur industry. It is recognized that there is poor education of breeders, outdated breeding theories, and unacceptable euthanasia methods are still being practiced (Hsieh-Yi et al., 2007). However, attempts are being made to improve China’s fur farming industry.

China is the largest fur manufacturer in the world but this position is impeded by a lagging fur farming industry (Petry & Liting, 2010). Increasing cost of production and a relatively inferior quality of Chinese pelts are impediments to growth in both domestic and foreign consumer markets (Petry & Liting, 2010). Some approaches can be used to improve the situation.

1. Improve the quality of the pelts by breeding stock selection

The local strains used in most of middle size and small size farms are not as good as those used in Denmark and North America. This is due to the poor selection of breeders and lack of experience. There are some excellent strains used in the large farms. China should accelerate the improvement in breeding stock in order to have excellent quality breeding mink. This high quality fur will compete more successfully on the world market. Many Chinese consumers ask for the garments which have fur that is imported from North America or Europe. This reflects the common belief that domestically produced fur does not yet meet top quality standards. So it is important to select the top quality breeders on farms and cull poor quality stock.

2. Lagging awareness of science & technology

Chinese fur farming is still lagging behind Denmark, Finland and North America. The quality of pelts can’t meet the international market demand and this is not conducive to market competition. Promoting scientific research for disease, nutrition, management, and welfare is necessary. Reinforcing the contact between scientists and the fur industry to improve the breeding and husbandry of fur animals is necessary.

3. Poor and unbalanced diets cause poor quality pelts

Fur farmed animals in the developed fur farming countries have proper and balanced diets, formulated to meet their nutrient requirements and therefore the fur quality is high. Chinese fur ranchers do not have enough experience, science and technology to provide proper nutrition. Providing poor quality feed to the fur animals sometimes causes problems. Good diets can produce high quality fur. Chinese mink farmers currently pay much more attention to curing diseases than nutrition. They are not aware of the importance of nutrition. Balanced diets can keep animals strong and healthy and prevent disease. It is necessary to change this situation and make the farmers realize the importance of nutrition. It is essential that mink ranchers should have complete knowledge of the nutritional requirements of mink as well as their management.

4. Improved management

New farm supplies and equipment should be produced in a unified standard. It is necessary to improve feeding facilities and use advanced feeding techniques in order to change the traditional methods of farming and promote modern management in the Chinese fur industry.

Specialized, consistent, reasonable, and standard management is essential for a successful fur farm business. Modern management can increase work capacity and improve work efficiency. Some large farms imported equipment and professional technology from Denmark and employed Danish experts for farm management. It is possible to master the new achievements, technology and knowledge of feed industry in order to keep improving.

Mink farms should have advanced equipment and technology. It is important to absorb the advanced technology and promote it, adapting it to national conditions. The farm will play an active leading part in the development of the Chinese mink feed industry, conforming to and reaching the advanced international levels.

5. Management of the fur industry

The market mechanism in China is not perfect. No standardization is available in fur farming management. There are some fur breeder associations in some countries, such as the Canadian Mink Breeder’s Association, Danish Fur Breeder’s Association, European Fur Breeder's Association, and others. But there are only a few fur breeder associations or fur federations in some regions of China. Information and experience can’t be shared with all farmers nationally in a timely way. Therefore, the fur industry develops blindly without communication and many farmers do not know how to feed and manage correctly. China is a large country and some fur associations are needed in all the provinces and a National Chinese Fur Breeder’s Association should also be formed. The fur association should be constructed with a mandate to introduce to the industry, management and experience from Denmark and North America.

All the associations should provide leadership in research, best farming practices, marketing, and promotion of the interests of the fur farming sector nationally and internationally. This will ensure the permanent prosperity of the Chinese fur farming industry. National and regional fur auction houses should be built. These can ensure the profit of farmers and help establish international standards of many fur farming activities in China.

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Construction of an American mink bacterial artificial chromosome (BAC) library and sequencing candidate genes important for the fur industry

R. Anistoroaei, B. ten Hallers, M. Nefedov, K. Christensen, P de Jong

Background: Bacterial artificial chromosome (BAC) libraries continue to be invaluable tools for the genomic analysis of complex organisms. Complemented by the newly and fast growing deep sequencing technologies, they provide an excellent source of information in genomics projects.
Results: Here, we report the construction and characterization of the CHORI-231 BAC library constructed from a Danish-farmed, male American mink (Neovison vison). The library contains approximately 165,888 clones with an average insert size of 170 kb, representing approximately 10-fold coverage. High-density filters, each consisting of 18,432 clones spotted in duplicate, have been produced for hybridization screening and are publicly available. Overgo probes derived from expressed sequence tags (ESTs), representing 21 candidate genes for traits important for the mink industry, were used to screen the BAC library. These included candidate genes for coat coloring, hair growth and length, coarseness, and some receptors potentially involved in viral diseases in mink. The extensive screening yielded positive results for 19 of these genes. Thirty-five clones corresponding to 19 genes were sequenced using 454 Roche, and large contigs (184 kb in average) were assembled. Knowing the complete sequences of these candidate genes will enable confirmation of the association with a phenotype and the finding of causative mutations for the targeted phenotypes. Additionally, 1577 BAC clones were end sequenced; 2505 BAC end sequences (80% of BACs) were obtained. An excess of 2 Mb has been analyzed, thus giving a snapshot of the mink genome.
Conclusions: The availability of the CHORI-321 American mink BAC library will aid in identification of genes and genomic regions of interest. We have demonstrated how the library can be used to identify specific genes of interest, develop genetic markers, and for BAC end sequencing and deep sequencing of selected clones. To our knowledge, this is the first report of 454 sequencing of selected BAC clones in mammals and re-assures the suitability of this technique for obtaining the sequence information of genes of interest in small genomics projects. The BAC end sequences described in this paper have been deposited in the GenBank data library [HN339419-HN341884, HN604664-HN604702]. The 454 produced contigs derived from selected clones are deposited with reference numbers [GenBank: JF288166-JF288183 &JF310744].

BMC Genomics, 2011: 12, 354.

Anchoring the dog to its relatives reveals new evolutionary breakpoints across 11 species of the Canidae and provides new clues for the role of B chromosomes

S.E. Duke Becker, R. Thomas, V.A. Trifonov, R.K. Wayne, A.S. Graphodatsky, M. Breen

The emergence of genome-integrated molecular cytogenetic resources allows for comprehensive comparative analysis of gross karyotype architecture across related species. The identification of evolutionarily conserved chromosome segment (ECCS) boundaries provides deeper insight into the process of chromosome evolution associated with speciation. We evaluated the genome-wide distribution and relative orientation of ECCSs in three wild canid species with diverse karyotypes (red fox, Chinese raccoon dog, and gray fox). Chromosome-specific panels of dog genome-integrated bacterial artificial chromo some (BAC) clones spaced at ∼10-Mb intervals were used in fluorescence in situ hybridization analysis to construct integrated physical genome maps of these three species. Conserved evolutionary breakpoint regions (EBRs) shared between their karyotypes were refined across these and eight additional wild canid species using targeted BAC panels spaced at ∼1-Mb intervals. Our findings suggest that the EBRs associated with speciation in the Canidae are compatible with recent phylogenetic groupings and provide evidence that these breakpoints are also recurrently associated with spontaneous canine cancers. We identified several regions of domestic dog sequence that share homology with canid B chromosomes, including additional cancer-associated genes, suggesting that these super-numerary elements may represent more than inert passengers within the cell. We propose that the complex karyotype rearrangements associated with

speciation of the Canidae reflect unstable chromosome regions described by the fragile breakage model.

Chromosome Res, 2011: Sep 27. [Epub ahead of print]

Inbreeding affects fecundity of American mink (*Neovison vison*) in Danish farm mink

D. Demontis, P.F. Larsen, H. Baekgaard, M. Sønderup, B.K. Hansen, V.H. Nielsen, V. Loeschcke, A. Zalewski, H. Zalewska, C. Pertoldi

Inbreeding is an increasing problem in farmed mink, because of limited exchange of individuals between farms. In this study, genetic relatedness within seven American mink (*Neovison vison*) colour strains originating from 13 different mink farms in Denmark was analysed using 21 polymorphic microsatellite loci. We detected large differences in the level of relatedness (range 0.017-0.520) within colour strains. Moreover, a very strong and highly significant negative correlation between the level of relatedness and fecundity was observed ($r = 0.536$, $P < 0.001$) [Correction added after online publication on 9 March 2011: r(2) has been changed to r]. To our knowledge, this is the first time that such a correlation has been demonstrated for commercially farmed mink.

Anim Genet, 2011: 42(4), 437-9
doi: 10.1111/j.1365-2052.2010.02155.x. Epub 2011 Feb 6.

Two candidate genes (FTO and INSIG2) for fat accumulation in four canids: chromosome mapping, gene polymorphisms and association studies of body and skin weight of red foxes

M. Grzes, I. Szczerbal, H. Fijak-Nowak, M. Szydlowski, M. Switonski

Fat accumulation is a polygenic trait which has a significant impact on human health and animal production. Obesity is also an increasingly serious problem in dog breeding. The FTO and INSIG2 are considered as candidate genes associated with predisposition for human obesity. In this report we present a comparative genomic analysis of these 2 genes in 4 species belonging to the family Canidae - the dog and 3 species which are kept in captivity for fur production, i.e. red fox, arctic fox and Chinese raccoon dog. We cytogenetically mapped these 2 loci by FISH and compared the entire coding sequence of INSIG2 and a fragment of the coding sequence of FTO. The FTO gene was assigned to the following chromosomes: CFA2q25 (dog), VVU2q21 (red fox), ALA8q25 (arctic fox) and NPP10q24-25 (Chinese raccoon dog), while the INSIG2 was mapped to CFA19q17, VVU5p14, ALA24q15 and NPP9q22, respectively. Altogether, 29 SNPs were identified (16 in INSIG2 and 13 in FTO) and among them 2 were missense substitutions in the dog (23C/T, Thr>Met in the FTO gene and 40C/A, Arg>Ser in INSIG2). The distribution of these 2 SNPs was studied in 14 dog breeds. Two synonymous SNPs, one in the FTO gene (-28T>C in the 5'-flanking region) and one in the INSIG2 (10175C>T in intron 2), were used for the association studies in red foxes ($n = 390$) and suggestive evidence was observed for their association with body weight (FTO, $p < 0.08$) and weight of raw skin (INSIG2, $p < 0.05$). These associations indicate that both genes are potential candidates for growth or adipose tissue accumulation in canids. We also suggest that the 2 missense substitutions found in dogs should be studied in terms of genetic predisposition to obesity.

Cytogenet Genome Res, 2011: 135(1), 25-32. Epub 2011 Aug 12.

Mink farms predict Aleutian disease exposure in wild American mink

L.A. Nituch, J. Bowman, K.B. Beauclerc, A.L. Schulte-Hostedde

Background: Infectious diseases can often be of conservation importance for wildlife. Spillover, when infectious disease is transmitted from a reservoir population to sympatric wildlife, is a particular threat. American mink (*Neovison vison*) populations across Canada appear to be declining, but factors thus far explored have not fully explained this population trend. Recent research has shown, however, that domestic mink are escaping from mink farms and hybridizing with wild mink. Domestic mink may also be spreading Aleutian disease (AD), a highly pathogenic parvovirus

prevalent in mink farms, to wild mink populations. AD could reduce fitness in wild mink by reducing both the productivity of adult females and survivorship of juveniles and adults.

Methods: To assess the seroprevalence and geographic distribution of AD infection in free-ranging mink in relation to the presence of mink farms, we conducted both a large-scale serological survey, across the province of Ontario, and a smaller-scale survey, at the interface between a mink farm and wild mink.

Conclusions/significance: Antibodies to AD were detected in 29% of mink (60 of 208 mink sampled); however, seroprevalence was significantly higher in areas closer to mink farms than in areas farther from farms, at both large and small spatial scales. Our results indicate that mink farms act as sources of AD transmission to the wild. As such, it is likely that wild mink across North America may be experiencing increased exposure to AD, via disease transmission from mink farms, which may be affecting wild mink demographics across their range. In light of declining mink populations, high AD seroprevalence within some mink farms, and the large number of mink farms situated across North America, improved biosecurity measures on farms are warranted to prevent continued disease transmission at the interface between mink farms and wild mink populations.

PLoS One, 2011: 6(7), e21693. Epub 2011 Jul 18.

Pancreatitis in Hyperlipemic Mink (*Mustela Vison*)

K. Nordstoga, R. Sørby, G. Olivecrona, A.J. Smith, B. Christophersen

In both man and animals, inflammatory changes in the pancreas often occur with disturbances in lipid metabolism, including hypertriglyceridemia and an excess of free fatty acids. Hyperlipoproteinemia type I is a human condition caused by a deficiency of lipoprotein lipase. A similar metabolic disturbance that occurs in mink is of considerable comparative interest, as it is also followed by pancreatitis. Pancreatic lesions in hyperlipo-proteinemic mink included overt variably sized nodules with hemorrhage and necrosis. These lesions began as intralobular necrosis of exocrine cells and progressed to total lobular destruction, with eventual involvement of interlobular tissue. Remnants of epithelial cells and lipid-filled macro-phages were seen in necrotic areas, along with other types of inflammatory cells scattered in a lipid-rich exudate. Granulation tissue developed rapidly in necrotic areas. Additional observations included ductal proliferation, replacement of epithelial cells with fat, and mural arterial thickening, most conspicuously with vacuolated cells and endothelial proliferation. Extravasation of lipid-rich plasma is thought to be a major intensifier of the inflammatory response.

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Actual Mink Research 2011

Meeting at Research Centre Foulum

Faculty of Science and Technology

Aarhus University, Denmark

20 September 2011

Molecular biological diagnostic of Aleutian mink disease virus in mink and environmental samples

T.H. Jensen, M. Chriél, A.S. Hammer

The aims of the project was to: 1) establish molecular biological diagnostic of Aleutian mink disease virus (PCR and sequencing), 2) develop methods to detect Aleutian mink disease virus (AMDV) in environmental samples and 3) describe the pathogenesis of AMDV in chronic infected mink. Here the main emphasis is to report the result of the first part of the project.

A PCR test for AMDV was established (Jensen et al. 2011). The efficacy of the PCR tested on spleen and lymph nodes was compared to the counter-current immune electrophoresis (CIE) performed at Kopenhagen Diagnostic. In total 299 mink organs from 55 recent infected farms and 8 non-infected farms ware collected from 2008-2010 and tested in both tests. The diagnostic sensitivity of the PCR was 94.7% when the PCR and CIE was done in parallel (Jensen et al. 2011). Concluding, the PCR is a good supplement to the serological test. Further, the PCR has the advantage that part of the viral genome is identified and subsequent sequencing can be used to describe the different strains of AMDV (Christensen et al. 2010).

Since the beginning of the project 109 samples was sequenced. In the majority of the samples (64%) the type Saeby/Den/799.1/05 which is regarded as the prototype of type 1 AMDV was identified. The majority of the other types identified were subtypes of type 1, only a few type 2 was identified. It is also important to note that the variations within the strains only are a few nucleotides and the practical importance of these variations is unknown.

Meeting at Research Centre Foulum, Faculty of Science and Technology Aarhus University, Denmark. Internal Report Husbandry no. 109, September 2011 (in Danish) p. 9. Authors' abstract.

Restricted and ad libitum feeding: what differences are observed in the metabolism?

M.S. Hedeman

Female mink are fed restricted during winter in order to slim them and prepare them for flushing. In an experiment with 30 female mink blood samples were collected during restricted feeding, four days after ad libitum feeding had started and after three weeks of ad libitum feeding. The female mink were divided into two groups; high and low residual feed intake.
The purpose of the experiment was to study whether there were differences in the metabolism between mink with high and low residual feed intake and to investigate the differences in the metabolism during restricted and ad libitum feeding. The blood samples were analyzed using a metabolomic approach, a technique that enables simultaneous measurement of a large range of metabolites (intermediates and products of metabolism). No difference was detected between female mink with high and low residual feed intake. In contrast, huge differences were observed in the metabolites in female mink fed restricted or ad libitum. The concentration of a range of metabolites (e.g. creatine, carnitine, and amino acids) that indicates that the body is mobilizing energy was increased in female mink fed restricted. On the other side, the concentration of lysophosphatidylcholine was low when the female mink were fed restrictively and increased in ad libitum fed female mink. The experiment illustrates how metabolomics can be used to identify

differences in the metabolism during different feeding regimens.

Meeting at Research Centre Foulum, Faculty of Science and Technology Aarhus University, Denmark. Internal Report Husbandry no. 109, September 2011 (in Danish) p. 11. Authors' abstract.

Feeding strategies for limitation of bite marks in mink kept in groups – preliminary results

S.W. Hansen, J. Malmkvist

Bite marks on the leather side of the fur can be quantified and thus represent an objective target of damages of the fur, like the bite marks located on body and tail can be interpreted as the animal's experienced aggression and thereby welfare. Bite marks appear in mink in groups more often than in mink traditionally kept in pairs and thereby represent an essential criticism of the climbing cages for production. Therefore, we have examined whether the number of feeding places and amount of food can reduce the occurrence of bite marks. The study showed that access to 3 feeding places reduced the number of bite marks and increased the skin length of the male. A reduction of ten percent in the amount of food affected neither the skin length nor the number of bite marks on body and tail, but reduced the number of bite marks in the neck. Black mink had more bite marks than Wild mink and Wild mink had more bite marks than Palomino and Redglow. Black and Wild female mink had more bite marks than similar males whereas no differences between sex could be proved in Palomino and Redglow. It is likely that the difference in bite marks between colour types is due to the fact that bite marks are easier to identify on dark furs than on light coloured furs.

Meeting at Research Centre Foulum, Faculty of Science and Technology Aarhus University, Denmark. Internal Report Husbandry no. 109, September 2011 (in Danish) p. 19. Authors' abstract.

"Clicker training" of mink

P.M. Svendsen

Using auditory cues for training animals, present advantages to the experimenters as sound can be detected by an animal with less strict orientation towards the cue than otherwise necessary when using visual cues. The aim of this experiment was to investigate whether using auditory cues is useful when training female American mink (*Mustela vison*). Fifteen female mink of the same production line of (brown) color type "wild" were tested using a habituation – dishabituation technique. It showed that using auditory cues is applicable when training female mink. Female mink respond actively to novel sounds and habituate rapidly without any difference between low and high frequency sound cues.

Meeting at Research Centre Foulum, Faculty of Science and Technology Aarhus University, Denmark. Internal Report Husbandry no. 109, September 2011 (in Danish) p. 35. Authors' abstract.

WelFur – assessing the welfare of mink in the European production

S.H. Møller, S.W. Hansen, R. Thomsen

European Fur Breeders' Association initiated the "WelFur" project in 2009 in order to develop a welfare assessment protocol for mink and fox farms after the standards developed in the EU project Welfare Quality®, that seems to develop into a standard for farm animal welfare assessment Europe. The assessment is based on four principles: 'Good feeding', 'Good housing', 'God health' and 'Appropriate behaviour' and 12 underlying criteria, to be measured at the farm. Based on validity, reliability and feasibility 22 measures have been selected for use in the three seasons of mink production: 1. Breeders during winter, 2. Dams with kits during spring, and 3. Juveniles during growth in the autumn, in order to cover the life cycle of the mink. The final welfare assessment is based on calculation of a welfare score for each of the four principles: 'Excellent', 'Above average', 'Acceptable' or 'Not classified'. The protocols for the three seasons are being tested in several countries and the Danish results shows that the WelFur protocol is sensible enough to discriminate between farms in the same category. It is concluded that it is possible to assess the welfare in mink using the principles developed in Welfare Quality®. The on-farm measures can be taken in one day facilitating potential implementation.

Meeting at Research Centre Foulum, Faculty of Science and Technology Aarhus University, Denmark. Internal Report Husbandry no. 109, September 2011 (in Danish) p. 39. Authors' abstract.

Selection against bitemarks in group housing - results from the first generation

P. Berg, S.H. Møller, S.W. Alemu

A selection experiment to reduce aggression in groups-housed mink is established, bu selecting against number of bite marks at pelting. This is done by recording bite marks on kits that have been two males and two females in a cage and subsequently select sibs from traditional housing for breeding. The selection experiment was started in 2009 and ends in 2011. Results from 2010 shows, that selection has an effect on number of bite marks, resulting in a marked difference between the two lines. Weight at pelting influences the number of bite marks and their distribution between mink in a group.

Meeting at Research Centre Foulum, Faculty of Science and Technology Aarhus University, Denmark. Internal Report Husbandry no. 109, September 2011 (in Danish) p. 48. Authors' abstract.

Agonistic behaviour in groups of four juvenile mink

L.L. Jeppesen

Group housing of mink leads to increased frequency of agonistic behaviour, fur damages, and bite marks on the leather side of the skins. Damages and bites are caused by the agonistic behavior. The frequency of agonistic behaviour can be reduced by environmental initiatives that minimize the competition in the group, e.g. two nest boxes to four juveniles instead of one. In this project it is examined if it is possible also to select for adaption to group housing by means of behavioural selection criteria. This is done by breeding two lines of mink, selected as being aggressive or peaceful on the basis of their fighting over newly delivered feed. This criterion is chosen because it is rather easy and reliable to register. In the first generations, which are considered here, the development of and the correlations between different behavioural and production related parameters is followed in order to find the best possible selection criteria. So far, the results suggest that spontaneous fighting correlates well with fur damages, bite marks, and the way the mink position themselves in the cage. However, spontaneous fighting occurs so infrequent that this kind of fighting is not well suited to be used as selection criterion. Fighting over newly delivered feed correlated less well with damages and bites, which reduces the applicability of this measure as a selection criterion. The selection lines selected on the basis of fighting over feed maintain nevertheless in their second generation a significant difference with respect to feed fighting, spontaneous fighting, positioning in cage, damages and weight.

Meeting at Research Centre Foulum, Faculty of Science and Technology Aarhus University, Denmark. Internal Report Husbandry no. 109, September 2011 (in Danish) p. 53. Authors' abstract.

Incidence of wounds and injuries in mink production

S.H. Møller

The prevalence of wounds and injuries in mink production has been in focus again in 2011. As part of our advice to the authorities we have examined available data on the prevalence under different conditions. The mortality of mink during the growth period in well managed farms and pair wise housing be around 1.1% of the weaned kits and 0.1% have bite wounds. Data on group housed kits are scarce and have been found only on few of the many potential combinations of number and sex. With two males and two females housed together a mortality of 4.4% was found and 2.1% had wounds. Inspection of mink in the cages revealed less than 1 percent with injuries and less than 1 in thousand with serious injuries demanding treatment or euthanasia. Almost half the serious cases were wounds. Examination of the dead bodies at pelting time revealed almost only wounds in the tail region.

The majority of these were minor lesions at the tip of the tail that was healed and could only be recognized by palpation. Unhealed wounds were found in 1.0 % of pair-wise and 3.8 % of group housed juveniles (including those in treatment). Untreated serious wounds were not found. It is concluded that very few serious injuries can be expected at inspection of mink in the cages during the autumn, and those that develop seems to be found in the daily surveillance of the animals. A thorough examination of the dead bodies at pelting will reveal less serious and healed wounds and injuries.

Meeting at Research Centre Foulum, Faculty of Science and Technology Aarhus University, Denmark. Internal Report Husbandry no. 109, September 2011 (in Danish) p. 61. Authors' abstract.

Death among mink kits in the lactation period

T. Clausen

To get an overview of the cause and number of dead kits in the nursing period, post mortem data were collected for several years at the research station Kopenhagen Farm. From birth until August 1st approx 6.3 % of kits die. From birth to day 28 only a few kits die, but in the end of May there is an increase. The courses of death in June are mainly diarrhoea, cachexia, and biting. Increased feeding intensity and water supply of the kits through the feed is important to avoid biting. Problems with bladder and kidney infections are seen from the middle of June.

Meeting at Research Centre Foulum, Faculty of Science and Technology Aarhus University, Denmark. Internal Report Husbandry no. 109, September 2011 (in Danish) p. 68. Authors' abstract.

Hunting new fur trait genes

J. Thirstrup, R.S. Labouriau, B. Guldbrandtsen, R.M. Anistoroaei, K. Christensen, M. Fredholm, V.H, Nielsen

Quality is a complex trait, consisting of guard hair length, guard hair thickness and density of wool. We performed a genome wide analysis (sex chromosomes not included) to find evidence for QTL for these traits. For the analysis we have used an F_2-design. Our results show evidence of QTL on 8 out of 14 autosomale mink chromosomes for guard hair length, guard hair thickness and density of wool. Three QTL for guard hair length and guard hair thickness showed the same position and inheritance. This indicates that the two traits to some degree are controlled by the same genes. The results identify only one significant QTL for density of wool on one chromosome

Meeting at Research Centre Foulum, Faculty of Science and Technology Aarhus University, Denmark. Internal Report Husbandry no. 109, September 2011 (in Danish) p. 75. Authors' abstract.

Effect of inbreeding on the breeding result in Danish mink

P.F. Larsen, H. Bækgaard, M. Sønderup, C. Pertoldi

Inbreeding has higher effect on the breeding result in farm mink than previously documented. In this study we studied the level of relatedness within seven mink colour strains originating from 13 different mink farms in Denmark. We detected a very strong and highly significant negative correlation between the level of relatedness and fecundity ($r = 0.536$, $P < 0.001$). Moreover, large differences in the level of genetic distance and relatedness within colour strains were observed (range 0.017–0.520). This suggests the possibility for applying genetic markers to minimize inbreeding and optimize the effect when buying in new breeding animals in the future. (Title: Effect of inbreeding on the breeding result in Danish mink).

Meeting at Research Centre Foulum, Faculty of Science and Technology Aarhus University, Denmark. Internal Report Husbandry no. 109, September 2011 (in Danish) p. 81. Authors' abstract.

Is genomic selection a revolution of breeding mink?

P. Berg

Genomic selection utilises, that individual mink can be genotypes for thousands of genetic markers. An individual's breeding value can be estimated with relative high accuracy based on a blood- and hair sample, where the animals' genotype is determined. It is not necessary to record the traits of interest on the mink itself. This means that breeding values for all traits can be estimated with a high accuracy early in an animal's life, before it is decided whether it is to be used for breeding or not. We don't know the accuracy that can be obtained yet, but based on other species, it will be realistic to expect a 2- to 4 fold increase of the genetic gain that is achieved today. To be economically feasible to utilize genomic selection this technology should be used in a small set of dedicated breeding herds.

Meeting at Research Centre Foulum, Faculty of Science and Technology Aarhus University, Denmark. Internal Report Husbandry no. 109, September 2011 (in Danish) p. 85. Authors' abstract.

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