

Essay in Wildlife ecology.

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Musk ox - *Ovibos moschatus*

Inbreeding among wild animals living in a small population is a theory with limited knowledge. On the other hand, inbreeding among wild animals in captivity is well documented. The reason for this is that it is very difficult to study inbreeding occurring in the natural environment of wild animals. To determine inbreeding one has to know the genetic relationship of the wild animals, a problematic task, especially in long lived animals. In addition one has to record and evaluate the negative effects of each individual. It has also been some disagreement about the extensiveness of inbreeding occurring in the nature suggesting it to be more rare than in captivity.

The musk ox belongs to the family Bovidae. It is a mammal with a thick, heavy coat which can protect the animals from temperatures down to 100 degrees F below zero. The musk ox lives in the tundra biome. Originally it lives in Arctic Canada, Greenland and Alaska, but it has also been successfully introduced to Dovrefjell in Norway. From this population a little herd of 5 animals emigrated to Härjedalen, a mountainous area in Sweden. The herd consisted of two adult females with one calf each and one 2-year-old male. The herd increased to more than 30 animals, before it started to decrease. Finally, in 1994, there were only 12 individuals left. This decrease was due to fecundity and longevity and led to the theory of inbreeding. A study was carried out to try to determine the possibility of inbreeding as the reason for the decrease of the herd.

The experiment consisted of observations of the Swedish musk ox herd in its natural environment. Information about the individuals were collected and analyzed on the basis of morphological features. Each year they were able to decide which cow that was giving birth to a calf, but they could not decide the parents of the calf. One reason for this is the lack of morphological features of the calves. The other reason is because of the breeding behaviour of the musk ox. Usually the herd consists of a dominant male with a harem of females. The bull will try to prevent other bulls from mating the females. But in the nature, the dominate bull is not always the father and one has to consider several males to the paternity. In this herd, there has also been observed a splitting of the herd into small groups consisting of a bull and some cows during the mating period. Because of this, a random number among the possible males and females was used to assign the parents to the calves.

The experiment used 6 models regarding the assumption on the mating behaviour and the genetic relationship. The models assumed a best and worst case regarding the genetic relationship, combined with harem or no harem.

To calculate the inbreeding coefficient one must have the complete pedigree. This was not present for the Swedish herd, which means that exact inbreeding coefficient was impossible to obtain. But the most important aim was an assessment of the relations between the inbreeding coefficients of individual animals, and by doing this they could use incomplete pedigrees to construct hypothetical pedigrees. From these hypothetical pedigrees they calculated the inbreeding coefficient of each individual.

The effect of inbreeding was evaluated by testing for the relationship of inbreeding coefficients with longevity and fecundity.

The experiment concluded that there is a high level of inbreeding in the herd of Härjedalen. When comparing the results with the few other studies concerning inbreeding done on other species, it shows that inbreeding depression is more severe in Musk Ox compared to other species.

But there has to be mentioned that the experiment is not fully reliable.

What seems to be the main problem is the information on the genetic relationship among individuals in the herd. This information is very difficult to obtain, partly because this is long lived animals and therefore will require long time studies, and partly because it is difficult to claim the maternity and paternity to the calves in the wildness.

Another important problem is the lack of environmental control. In experiments performed in the natural environment it is very difficult to create any controlled experimental situation.

This means that there may exist other factors which influenced the decrease in the reproduction during the years. It is also impossible to compare the result obtained with a control group. In addition it is difficult to exclude the possibility of the decrease in the reproduction due to the effect of individual animals.

This makes the experiment a bit less reliable than studies made in captivity.

Small wild populations in decreased habitats often suffer from reduction of genetic diversity due to genetic drift and inbreeding effects. Inbreeding depression reflects the negative consequences of increased homozygosity at genes that affect fitness. The loss of genetic variation can lead to short-term reduction of fitness components such as survival, reproductive output, growth rates and impaired ability to adapt to long-term changes in the environment. Inbreeding depression can be substantial in wild populations and can also contribute to the extinction of a population. In some cases it has also been environment and sex dependent.

There are facts about the musk ox that strengthens the theory about inbreeding. The herds of the musk oxen is often founded by few individuals. An example is the musk ox in Alaska. The 3300 musk oxen living in Alaska are descendants of the 30 Greenlanders brought there 70 years ago.

There has been done some collecting and analyses of tissue samples from dead musk oxen. These samples pointed out a large degree of inbreeding of the 75 000 musk ox living in the High Arctic. At the same time a genetic testing of 75 animals showed almost identical DNA.

The musk ox has few natural predators. The only real enemy is the arctic wolf. When the musk ox feels threatened, it does not run away, but form a defensive circle around their young, and face their enemies. Predators will have a minor influence on the decrease of the herd.

It seems that the inbreeding is a dominating factor in the decrease of the musk ox herd. But it should be noticed that there exist other reasons as well.

The dominating factor of decreases in the Norwegian musk ox population has been human caused mortalities. This included shooting and train accidents. The musk ox got exterminated during World War II because of hunting, and a new herd had to be introduced. Another reason is emigration to other areas, for example Sweden. Some natural mortality also occurs. The study of the Norwegian musk ox population also showed correlation to the climate. Annual variations in growth rate were related to the autumn and winter climate. It showed an

increase in years with mild weather. The musk ox seems to be sensitive for climatic changes. An attempt to introduce the musk ox to the coast of Norway failed, because the musk ox could not survive the climate.

But even though the musk ox in Norway shows a lower growth rate than in Alaska and Greenland, the herd has increased dramatically from 1990. From the original herd on 23 animals, the herd in 2006 contains 213 animals.

The musk ox prefer windblown areas, like ridges and hills, and select feeding sites with little snow depth. This is due to the adaptation to arctic tundra environments. The marginal winter conditions and difficulties regarding the adaptation to Sweden may also be an important reason for the decrease of the Swedish musk ox herd. It can also explain why the musk ox has failed to establish itself outside of Dovre in Norway. But again, these difficulties in adaptation may be due to inbreeding and its effects.

The climate is a major problem not only in Sweden. The musk ox managed to survive the last ice age. They are very well adapted to life in the High Arctic. But now this environment is warming up, and makes a threat for the musk ox. At the time, the warming makes a lot of food to the animals and the population of musk ox is rising. But if the temperature continues to increase this will make big problems for the musk ox. Because of the high degree of inbreeding, the musk ox will have difficulties to adapt to the new environment since the lack of genetic variation gives them weak defense against any new elements in their environment.

Many studies indicate the inbreeding among small musk ox populations to be relative high, and this is probably the major reason for the decrease of musk ox, such as in Sweden. Larger herds usually have their origin from few animals, and the decrease of certain herds is a fact. But we have to take into consideration the difficulties of experiments with wild animals in their natural environment. We also have to be aware of the other reasons which contribute to the decrease in the musk ox population. Among these are the human caused mortalities and adaptation problems due to the climate. The musk ox may also face problems in the future, due to the changes of the climate in the High Arctic. If these habitats are warming up, the musk ox and other animals will be affected.

Sources:

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