

Arctic Fox *Alopex lagopus* L. color phases in South Norway

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Arctic Foxes (*Alopex lagopus*) exhibit two color phases, white and blue, with some variation within each. The coat color of Arctic Foxes observed in south Norway, Arctic Fox skins from Stockholm Museum and foxes on photos encountered in literature are described. Three distinct types of white foxes were found, judging from their summer pelage. One type had a grey dorsal side and a white ventral side, a second type had a brown dorsal side and a white ventral side with a yellowish band of varying broadness in between and the third type was nearly uniformly dark brown but with the characteristic white snout of the white fox. Based on winter pelage blue foxes could be classified into two main types. Some blue foxes were found to be dark grey or brownish grey, and would in some cases look nearly black. A second type of blue fox winter pelage had to a varying extent white hairs dispersed throughout, giving the fox a greyish or whitish appearance. Some blue foxes observed in spring had remains of white winter fur, probably caused by bleaching by the sun and wear from wind and snow of an original pale pelage. All blue foxes had a grey underfur and their summer pelage was uniformly brown.

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INTRODUCTION

The Arctic Fox *Alopex lagopus* L. has a circumpolar distribution. Throughout most of its range Arctic Fox populations are described as consisting of two color phases: white and blue foxes (Collett 1912, Braestrup 1941, Pedersen 1959, Macpherson 1969, Chesemore 1970, Hersteinsson 1984). In the Soviet Union, Greenland and North America Arctic Foxes are trapped regularly in the winter season and the winter fur is well known. The colors of the summer fur are often poorly described, however. Arctic Foxes are also widespread as farm animals and have been bred for their fur for over 50 years. The inheritance of the color has attracted some attention in farm foxes (Slagsvold 1949, Johansson 1960, Nes 1978, Nes et al. 1983, 1987) and recently also in wild foxes (Hersteinsson 1984, Adalsteinsson et al. 1987).

White foxes are commonly described as having a white winter fur and a summer fur with dark dorsal side and light ventral side, while blue foxes are dark brownish or blackish throughout the year. However, a considerable variation in the coloration of the win-

ter fur of Arctic Foxes has been found in several countries. Boitsov (1937) distinguished between four types of blue foxes, from dark brownish to white ones. Gunnlaugsson (1955) stated that it would be difficult to categorize the Icelandic Arctic Fox by color, with the blue fox responsible for most or all of the variation. Gunnlaugsson (1955) identified 6 main categories of Arctic Foxes. Recently, Adalsteinsson et al. (1986, 1987) have demonstrated the great variation in the coloration of the Icelandic Arctic Fox.

Johansson (1960) distinguished between Greenland and Alaska blue foxes. The «bluish» coat color of the Greenland blue fox is due to a mixture of white and pigmented hairs so that the shade of color depends on the proportion of white to pigmented hairs. The Alaska blue foxes, however, are described as uniformly dark (Johansson 1960). The Greenland blue fox may be the wild type most resembling the blue foxes raised in farms.

Another subject to confusion are the very young pups. White fox pups are as dark or

nearly as dark as blue pups when born, but become progressively lighter on the ventral surface and along the body sides (Johansson 1960). This means that white pups in their first weeks of life may be hard to separate from their blue littermates (Freuchen 1935).

In a study of Arctic Foxes in southern Norway some blue foxes were observed that did not fit into the general description. A further investigation revealed that the color of the Arctic Fox pelage may need a thorough description, and the purpose of this paper is to describe the color of foxes observed in southern Norway and southern Sweden and of fox skins from Stockholm Museum.

MATERIAL AND METHODS

In the years 1981 and 1982 the behaviour of Arctic Foxes in the denning area was studied in two mountain regions in South Norway, Finse (Hordaland county) and Sylane (Sør-Trøndelag county), respectively (Frafjord 1984, 1986). These studies were continued to a varying extent in the years 1983—1986 in the Sylane region. Observations were made from May to September. Each fox was described as accurately as possible with respect to coat color and other characteristics, the main purpose of this description was to re-

Table 1. Arctic Fox colour phases observed at dens in South Norway (N) and Sweden (S) in the period 1981—1986. Some of the foxes observed in the same region in different years may be the same individuals.

| Region | Year | Pups | | Adults | |
|------------|------|-----------|----------|-----------------|-----------------|
| | | White fox | Blue fox | White fox | Blue fox |
| Finse (N) | 1981 | 2 | 10 | 0 | 4 |
| Sylane (N) | 1982 | 5 | 7 | 0 | 3 |
| Sylane (S) | 1982 | — | — | — | 1 ¹⁾ |
| Sylane (N) | 1983 | 0 | 0 | 0 | 2 |
| Sylane (N) | 1984 | 0 | 0 | 1 | 2 |
| Sylane (S) | 1984 | 7 | 0 | 2 | 0 |
| Sylane (S) | 1984 | — | — | — | 1 ²⁾ |
| Sylane (N) | 1985 | 10 | 1 | 1 | 1 |
| Sylane (S) | 1985 | 13 | 0 | 4 | 0 |
| Sylane (N) | 1985 | — | — | 1 | — |
| Sylane (N) | 1986 | 0 | 0 | 1 | 0 |
| Sylane (S) | 1986 | 0 | 0 | 1 | 0 |
| Sylane (S) | 1986 | — | — | 1 ²⁾ | — |

1) Not observed at den

2) Found dead

cognize individual foxes for a prolonged time. Photos were taken of as many foxes as possible. Included are also foxes at two dens in Sweden, close to the Norwegian border in Sylane. Since some foxes observed in one region throughout different years might be the same individuals, a total number of foxes observed cannot be given (Tab. 1).

Skins of 18 Arctic Foxes at Stockholm Museum (collected since 1867) were examined and photographed there in 1984. Also, photos of Arctic Foxes encountered in literature or otherwise were examined.

To be sure, most foxes have to be observed through several seasons for a classification based on pelage color. In this study three main types of white foxes and two main types of blue foxes are suggested (Tab. 2).

Table 2. Main color phases of Arctic Foxes.

| Type | White fox summer fur | Type | Blue fox winter fur |
|------|--|------|---|
| I | Grey dorsal side and white ventral side | I | Dark grey or brownish grey, may look nearly black |
| II | Brown dorsal side and white to greyish ventral side with a yellowish band in between | II | White or greyish white |
| III | Nearly uniform, dark brown with a narrow lighter ventral side | | |

Table 3. Coat colour of white fox skins in Stockholm Museum. Su = summer, a = autumn, w = winter. N. = North, C. = Central. Cat.nb. = catalog number. Foxes of unknown origin (?) were probably from early domestic stocks.

| Origin | Summer pelage | Winter pelage | Cat.nb. |
|----------------|--------------------|---------------|---------|
| C. Sweden (su) | brown/yellow/white | white | A581017 |
| ? (a) | grey/white | white | A581016 |
| Siberia (w) | — | white | A590493 |
| ? (w) | — | white | A581525 |
| ? (w) | — | white | A581006 |
| N. Sweden (w) | — | white | A710029 |
| Siberia (w) | — | white | A581018 |

RESULTS

White foxes

Pups could easily be classified as either white or blue foxes when they first emerged from the den about 3 weeks old (Tab. 1). When emerging from the dens the white pups had a lighter belly than the blue pups and also a lighter ventral surface of the head and neck. As the pups grew, this light ventral surface progressively increased upwards along the body sides.

Adult and young white foxes could be distinguished to two main categories (type I and II, Tab. 2). The two white fox pups observed at Finse in 1981 were of type I, while all white foxes observed subsequently, both pups and adults, were of type II (Tab. 1).

At Stockholm Museum pelts of 7 adult white foxes were available. Two white foxes in summer pelage were similar to the type II foxes, while the white foxes in winter pelage all had a small proportion of black-tipped guard hairs and the innermost part of the dorsal underfur was grey (Tab. 3).

Two photos of a third type of white foxes were found. These white foxes in summer pelage had only a very narrow light ventral side, so that they were brownish or greyish over most of the body (Tab. 2). However, all of them had the characteristic white snout of the white fox.

Blue foxes

Pups of the blue color phase were uniformly grey, with some individuals growing lighter grey with age (observed to about 3 months of age) (Tab. 1). It was not possible to classify pups as either type I or II blue foxes.

Adult blue foxes all had a uniform brown summer pelage, not grey as the pups, but could be put into two different main types judging from their winter fur (Tab. 2). (Adults are shedding their winter fur slowly, and may retain some parts of it until August.) The type I blue fox agrees with the common description of blue foxes in Norway, while the type II does not and requires some attention. These type II blue foxes were observed in 1981 and 1982, both at Finse (four foxes) and in Sylane (three foxes) (Tab. 1). One blue fox observed in 1984 also resembles type II.

One example of this color type was a white male observed at a den in May 1982. When visiting the den in June, the male was consi-

Table 4. Coat colour of blue fox skins in Stockholm Museum. Sp = spring, su = summer, a =autumn, w = winter. N. = North, C. = Central. Cat.nb. = catalog number. Foxes of unknown origin (?) were probably from early domestic stocks. Brown in brackets indicates that the fox had many brown or brown-tipped hairs, even though its main appearance was different.

| Origin | Summer pelage | Winter pelage | Cat.nb. |
|----------------|---------------|---------------|--------------------------|
| Jan Mayen (sp) | grey (brown) | brown | A582001 |
| N. Sweden (su) | brown | white (brown) | A750034 |
| N. Sweden (su) | grey (brown) | — | A591009-12 ¹⁾ |
| Arctic (su) | grey (brown) | white (brown) | A582106 |
| ? (a) | — | greyish white | A590205 |
| ? (w) | — | grey (brown) | A589501 |
| C. Sweden (w) | — | grey (brown) | A785039 |
| C. Sweden (w) | — | grey (brown) | A7965013 |
| C. Norway (w) | — | grey (brown) | 2) |

1) Four small pups.

2) Directorate for Nature Management, Norway.

dered to be the same as in May and he was still very much white, but beginning to shed his winter fur. At this time it was uncertain whether he was a white or blue fox, as his winter fur was as white as the snow. However, his summer pelage turned out to be as uniform brown as a blue fox.

One female blue fox found dead in Sylane in 1984 had a uniform brown summer pelage, with a few longer winter hairs (Frafjord 1985). However, these winter hairs were of two different colors, white on the body and black on the tail.

At Stockholm Museum 7 adult blue foxes and 4 blue pups (from the same litter) were examined. All skins of blue foxes had a brownish or greyish appearance, the summer skins were more brown and the winter skins were more grey (Tab. 4). The underfur of all blue foxes was grey, and in some foxes responsible for a grey appearance, as the density of the guard hairs was too low to cover the underfur completely. Two blue foxes in summer pelage had retained some winter fur which was white, while a third had retained some grey winter fur (type II).

A special case was fox no. A590205 at Stockholm Museum. Most likely a blue fox killed in the autumn while the winter fur was developing, the guard hairs of his winter fur were whitish or greyish white (type II).

All the blue foxes, including the four small

pups, had some white-tipped guard hairs dispersed over their body and a few had some dark or black hairs.

During the spring moult the brown color of both white and blue foxes often looked nearly black, but quickly faded to the common chocolate brown.

DISCUSSION

The blue foxes observed in this study could well be native to Norway, as a great proportion of variation has been found elsewhere (Pedersen 1926, Boitzov 1937, Adalsteinsson et al. 1986, 1987). The variation observed in the Norwegian Arctic Foxes may not be larger than could be expected. However, the more or less white spring pelage of the type II blue fox could also be a result of the effect of the sun bleaching the fur (Freuchen 1935, Hersteinsson pers. com.) and from the wearing effect of wind and snow. Despite this, some genetical effect seems to be operating since not all blue foxes became white in spring.

Arctic Foxes are widespread in fur farms in Norway and it is well known that many foxes have escaped during the years. These farm foxes are a genetical mixture with main origin from Greenland and North America (Nes et al. 1987). The famous «Nordic blue fox» is selected for its light winter pelage color (Nes et al. 1987). Escaped farm animals could very well influence the natural population in South Norway, as this population is very small (Frafjord 1988), and certainly photos of strange colored free-living Arctic Foxes do show up regularly. However, it is worth noting that the summer pelage of the farm blue fox (both adults and pups) seems to be darker than that of wild Norwegian foxes.

The blue foxes observed in this study with white remainings of winter fur in spring, were most likely of the «Greenland» type having their fur bleached and worn throughout winter. If the blue foxes with white remains of winter fur observed in the spring in South-Norway really had a white or whitish winter pelage, they cannot easily be distinguished from white foxes in winter. This could lead to an overestimation of the numbers of white foxes, which are assumed to outnumber the blue fox in Norway (Johnsen 1947). These pale colored blue foxes could have a camouflage advantage to dark blue foxes in white winter conditions, while they could have an

advantage to white foxes in dark summer conditions.

Some interesting pleiotropic effects may also be involved. When emerging from the den, white pups could be seen to have a more limited ear movement than blue pups, and white foxes have wider forepaws than blue foxes (Hersteinsson 1987). It may well be that physiological, morphological and behavioural characteristics in Arctic Foxes are related to different environmental conditions. For the Red Squirrel *Sciurus vulgaris* Voipio & Hissa (1970) suggested that structural features of the pelage are responsible for a varying frequency of color types with environmental conditions. This could also be the case for the Arctic Fox, with a likely addition of the camouflage value of the Arctic Fox pelage. Geographic variation in the occurrence of blue foxes has been found both in Canada (Fetherston 1947) and Iceland (Hersteinsson 1984), and Braestrup (1941) distinguished between «lemming foxes», mainly white foxes, and «coast foxes», mainly blue foxes. Johansson (1960) mentioned that the Greenland Arctic Fox is smaller than the Alaska fox, but capable of storing more body fat, and Arctic Fox populations do also seem to differ with respect to litter size.

The few main color phases of Arctic Foxes described in this study may be strictly non-overlapping categories. However, they could also be points on a continuum of variation within the classes of white and blue foxes.

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REFERENCES

- Adalsteinsson, S., Hersteinsson, P. & Gunnarsson, E. 1986. Ræktun islenska melrakkans. *Freyr* 62: 785—789.
- Adalsteinsson, S., Hersteinsson, P. & Gunnarsson, E. 1987. Fox colors in relation to colors in mice and sheep. *J. Hered.* 78: 235—237.
- Boitsov, L. V. 1937. The arctic fox: biology, food-habits, breeding. *Trudy Arkt. Nauchno-Issled inst.* 65: 7—144. (Transl. in the Elton Library, Oxford).
- Braestrup, F. W. 1941. A study of the arctic fox in Greenland. *Medd. Grønl.* 131: 1—101.
- Chesemore, D. L. 1970. Notes on the pelage and priming sequence of arctic foxes in northern Alaska. *J. Mammal.* 51: 156—159.
- Collett, R. 1912. *Norges virveldyr. Bd. 1, Norges pattedyr.* Aschehoug & Co., Kristiania.
- Fetherston, K. 1947. Geographic variation in the incidence of occurrence of the blue phase of the arctic fox in Canada. *Can. Field-Nat.* 61: 15—18.
- Frafjord, K. 1984. *Fjellrevens (Alopex lagopus) atferd i hiområdet.* Unpubl. Cand. real. Thesis, Univ. Trondheim.
- Frafjord, K. 1985. Notes on a large arctic fox skull. *Fauna Norv. Ser. A* 6: 55.
- Frafjord, K. 1986. Etogram over fjellrevens atferd i hiområdet. *Medd. norsk Viltforsk.* 3: 1—52.
- Frafjord, K. 1988. Betraktninger omkring fjellrevbestanden i Sør-Norge perioden 1981—1985. *Fauna* 41: 35—39.
- Freuchen, P. 1935. Field notes and biological observations. Part II. Report of the mammals collected by the Fifth Thule Expedition to arctic north America. *Rept. 5th Thule Exped. 1921—1924:* 1—278.
- Gunnlaugsson, T. 1955. *Á réfaslóðum.* Búnaðarfélag Islands, 384 pp.
- Hersteinsson, P. 1984. *The behavioural ecology of the arctic fox (Alopex lagopus) in Iceland.* Dr. phil. Thesis, Univ. Oxford.
- Hersteinsson, P., Adalsteinsson, S. & Gunnarsson, E. 1987. Is there a difference in the shape of paw prints between blue and white arctic foxes? *Wildl. Mngmnt News, Iceland* 3: 11—15. (In Icel., summ. in Engl.).
- Johansson, I. 1960. Inheritance of the color phases in ranch bred blue foxes. *Hereditas* 46: 753—769.
- Johnson, S. 1947. Fjellreven. Pp. 308—322 in Føyn, B. & Huus, J. (eds.). *Norges Dyreliv, bd. 1: Pattedyr.* J. W. Cappelens Forlag, Oslo.
- Macpherson, A. H. 1969. The dynamics of Canadian arctic fox populations. *Can. Wildl. Serv. Rep. Ser. No. 8:* 1—52.
- Nes, N. 1978. Blårevens og sølvrevens fargemutasjoner og deres genetikk. Artikkel I. *Norsk Pelsdyrblad* 52: 414—419.
- Nes, N., Einarsson, E. J. & Lohi, O. 1987. *Vakre pelsdyr – og deres fargegenetikk.* Scientifur, Hillerød.
- Nes, N., Lohi, O., Olausson, A. & Hansen, H. A. 1983. The genetic factors for colour types in ranch bred foxes. *Acta agric. Scand.* 33: 385—388.
- Pedersen, A. 1926. Beiträge zur Kenntnis der Säugetier- und Vogelfauna der Ostküste Grönlands. *Medd. Grønl.* 68: 151—249.
- Pedersen, A. 1959. *Der Eisfuchs Alopex lagopus Linné.* A. Ziemsen Verlag (Neue Brehm Büch.), Wittenberg — Lutherstadt.
- Slagsvold, P. 1949. Nedarving av den blå og hvite farge hos polarreven (*Alopex lagopus*). *Nord. Veterinaermed.* 1: 429—441.
- Voipio, P. & Hissa, R. 1970. Correlation with fur density of color polymorphism in *Sciurus vulgaris*. *J. Mammol.* 51: 185—187.

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