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**BREEDING TRAITS AND HEREDITARY DISORDERS OF THE
NORWEGIAN FOREST CAT DURING BREED DEVELOPMENT
(A REVIEW OF LITERATURE)**

Diploma work

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ABSTRACT

The Norwegian forest cat (NFC) became domesticated in the 1930`s, and a registered breed by FIFe 40 years later. The NFC`s health status today is parallel to its breeding history. After WWII, the breeding has been very strict in order to preserve natural traits. The NFC is generally a healthy breed with few hereditary diseases. The most common genetic diseases are Glycogen storage disease IV, Hypertrophic cardiomyopathy and Hip dysplasia. Seen in comparison with other pedigree cats, the NFC has less diseases and disorders and can live up to 20 years with good care.

LIST OF CONTENT

1. Introduction	4
1.1 History and background	4
1.2 Breed Description	6
1.2.1 Physical characteristics	6
1.2.2 Personality and temperament	7
1.2.3 Care	8
2. Methodology	9
3. Results	11
3.1 Breeding traits	11
3.1.1 Development of breed standard	11
3.1.2 Rules of breeding NFC	12
3.2 Hereditary disorders	13
3.2.1 Musculoskeletal disorders	13
3.2.1.1 Glycogen Storage Disease IV	13
3.2.1.2 Hip Dysplasia	15
3.2.1.3 Patellar Luxation	17
3.2.2. Cardiovascular disorders: Hypertrophic Cardiomyopathy	19
3.2.3 Retinal Degeneration	21
3.2.4 Polycystic Kidney Disease	22
3.2.5 Eosinophilic Granuloma Complex	24
4. Conclusions	26
4.1 Breeding traits and history	26
4.2 Health status today	26
4.3 Preventative measures	27
5. List of references	30

1. INTRODUCTION

1.1 History and background of the Norwegian Forest Cat

It is believed that the Vikings and Crusaders brought longhair and shorthair cats from England to Norway around 1000 AD.¹ They functioned as mouse hunters to keep the Viking ships free from mice. These cats are believed to be the ancestors of the traditional Norwegian Forest Cat (NFC) by reproducing with the Norwegian farm cats over time. The farm cat was an excellent climber, fisher and hunter, and was called “the mountain cat” due to its abilities.² It is also believed that the Norwegian Forest cat descends from Turkish Angora cats, that later mated with native Nordic shorthairs.

Although the ancestry is somewhat unclear, The NFC might have evolved in the forest and mountains in Norway and Sweden. The cats were seen as wild, and did not interact with humans. They lived around farms due to grain that attracted mice, and mice attracted the cat. Because of cold climate and harsh terrain, the cat adapted a long and thick fur, in addition to its many other great abilities. It is said that the NFC loves water due to its ancestry among the rivers catching fish.

In the 1930s the NFC had become a domestic cat and attracted attention by European breeders. People realized how valuable this cat was, and became interested in preserving the breed. Since the NFC kept mating with other farm cats, breeders developed a pedigreed NFC to keep the true breed alive.

The cat club in Norway featured the cat in 1938. The NFC appeared in cat shows in Germany as one of the most popular breeds. The judges showed high interest and enthusiasm. However, during the Second World War, cat breeding was a low priority, and therefore had a bad effect on a number of cat breeds including the NFC.³

¹ Saetre Raymond. : The Norwegian Forest Cat Society UK, History
<http://www.tnfc.co.uk/History/BreedHistory.html>
Visited 19.05.2012 at 23.30

² Pet Source : Norwegian Forest Cat History and Challenges
<http://www.petsource.org/catbybreeds/968-norwegian-forest-cat.html>
Visited at 19.05.2012 at 13.00

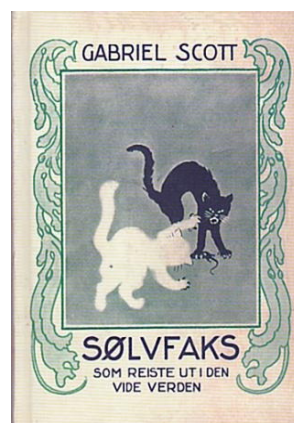
³ Saetre: The Norwegian Forest Cat Society UK, History
<http://www.tnfc.co.uk/History/BreedHistory.html>

The Norwegian National Association of Pedigree Cats was founded in 1963 to help the breed make a comeback, by developing an official breeding program.⁴ The NFC was registered as a breed in the Fédération Internationale Féline in 1977.⁵ The Cat Fanciers` association of the United States officially acknowledged the breed in 1987, and was given full championship status in 1994.

Today, the NFC is very popular in Scandinavia, the United States and France.

In Norway, the NFC is called “skogkatt” and has appeared in folk tales many times, including the popular Asbjornsen and Moe’s stories.⁶ In 1912, the Norwegian author Gabriel Scott also wrote a very well-read children’s book called "Sølvsfaks" (Silverfaks). Silverfaks travelled the world chasing mice, fighting the European Magpie, escaping from the fox and fighting other cats.

Photo: Novel about the Norwegian Forest Cat “Sølvsfaks”.⁷



Visited 19.05.2012 at 23.30

⁴ Saetre: The Norwegian Forest Cat Society UK, History

<http://www.tnfcs.co.uk/History/BreedHistory.html>

Visited 19.05.2012 at 23.30

⁵ Vanda Clunas 1997: The Arrival of Norwegian Forest Cats in the UK

http://www.klatringkatt.com/Norwegian_Forest_Cat/NFC_breed_history.html .

Visited 20.05.2012 at 21.00

⁶ Ehrhardt Tanja, Norwegische Waldkatzen : The Story of the Norwegian Forest Cat

http://www.swisskogkatt.ch/en/n_geschichte.asp

Visited at 20.05.2012 at 14.00

⁷ Photo:

<http://www.bokogmedia.no/bokogmedia/content/mma/products/03/344/34490/gwi600x1000/9788291674131.jpg>

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1.2 Breed Description

1.2.1 Physical Characteristics

The Norwegian Forest Cat is larger and stronger than an average cat. According to breed standards the head should be long and triangular.⁸ Round and square shaped heads are considered a defect. The eyes could be of any colour except blue, and the shape should be almond shaped and oblique. A cat with blue eye colour is accepted only if the fur coat is white.⁹ The ears are very characteristic, being large and with hair protruding from the pinna, giving the cat the looks of a lynx. As a matter of fact, in 1559 the Danish priest Peter Clausson Friis said that the NFC and the lynx had many similarities. The shape of the ears should not be round.

The body is strong and medium long. The legs should be in proportion to the body with hind legs being longer than fore legs.

The tail should be at least as long as the body and it should be bushy. The neck is muscular and medium length.¹⁰

*Photo: The Norwegian forest cat.*¹¹



⁸ FIFe web: Norwegian Forest Cat, Head
<http://www1.fifeweb.org/dnld/std/NFO.pdf>
Visited 17.09 2012 at 20.40

⁹ FIFe web: Norwegian Forest Cat, Eyes
<http://www1.fifeweb.org/dnld/std/NFO.pdf>
Visited 17.09 2012 at 20.40

¹⁰ FIFe web: Norwegian Forest Cat, Body
<http://www1.fifeweb.org/dnld/std/NFO.pdf>
Visited 17.09 2012 at 20.40

¹¹ Photo: <http://catmess.blogspot.no/2009/11/cat-breeds-norwegian-forest-cat.html>

The length of the coat should be semi-long. The texture is dense with a smooth water repellent outer coat covering the inner woolly coat. The outer coat is typically long and glossy. All colours are accepted with the exception of Amber/light amber, chocolate, lilac, cinnamon, fawn and the oriental pointed pattern.¹²

The body weight of female is 5-7 Kg, and male is 6-10 Kg. The life span is expected to be 15-20 years with good care.

Typical faults of the breed standard is; small or delicately built, round or square head, round eyes, small ears, short legs, short tail not reaching back of shoulder blades, dry or too soft coat.

1.2.2 Personality and temperament

Even though the NFC have a great affection for the outdoors, it still likes being in company of humans and other pets. While it is a social breed, it is also very affectionate. They have been described by many owners as calm, stable, patient and even-tempered. NFC seldom shows signs of aggression, which makes them great companions of families with children.¹³

The activity level of NFC is high, especially if permanently kept indoors which is not recommended for this breed. They are suited to living outdoors for longer periods, where they manage to find food themselves by hunting rodents and birds.

The NFC will seek out high places, and are excellent climbers due to their long muscular legs and large paws. Indoors, it is not uncommon to find the NFC on top of cabinets and tall shelves.

¹² FIFe web: Norwegian Forest Cat, Coat
<http://www1.fifeweb.org/dnld/std/NFO.pdf>
Visited 17.09 2012 at 20.40

¹³ Pet wave : Personality
<http://www.petwave.com/Cats/Breeds/Longhair/Norwegian-Forest-Cat/Temperament.aspx>
visited 20.05.2012 at 13.00

Table 1: Personal characteristics of Norwegian Forest Cat¹⁴

• Playfulness	High
• Intelligence	Very High
• Independence	Medium
• Attention Seeking	Medium
• Affectionate	Very High
• Activeness	High
• Friendliness to Children	High
• Friendliness to other Pets	High

1.2.3 Care

The grooming of the NFC varies depending on the season. In spring, the cat sheds its longer winter coat and will adapt a lighter and shorter summer coat. In this period it can be necessary to comb the cat daily. This will help to keep the fur look healthy and stay in good quality. It has been said that the NFC “molts”, because the cat changes its looks dramatically due to the loss of the winter coat.

Photo: NFC with its typical characteristics. ¹⁵



¹⁴ Table from findakitten.com, Personality and temperament
<http://www.findakitten.co.uk/norwegianforest.html>
visited 20.05.2012 at 13.25

¹⁵ Photo: http://www.norkatz.com/Jami%20Walking_C2140004.JPG
Visited 07.10.2012

2. METHODOLOGY

Before starting writing “Breeding traits and heritable diseases of Norwegian Forest cat during breed development, a review of literature”, I made several scientific searches on the internet. I used PubMed and Google books, as well as general Google search. I read a previously written thesis, by Pernille Fageraas. “Breed Status of the Norwegian forest cat from a viewpoint of eugenics” was a good help to get started.

The history of Norwegian forest cat was well described by Saetre Raymond. : The Norwegian Forest Cat Society UK, History.

When searching for breeding traits, I found out that FIFe`s web-page was the most informative. FIFe`s Norwegian Forest cat breed standard table contains all the information needed for traits.

I also found a web site called www.winterfyre.com/testing, which listed some heritable diseases of the NFC. This is a web page where owners of NFC`s can post their lab DNA-test results to share with other owners. The diseases represented here is Polycystic kidney disease, Hypertrophic cardiomyopathy, Brainstem auditory evoked response, Glycogen storage disease IV, and Chronic interstitial nephritis.

For Glycogen storage disease type IV, I used several informative articles. Longford Veterinary services online could tell me about the genetics behind the disease, as well as diagnostic methods. http://www.langfordvets.co.uk/lab_pcr_gsd4.htm

I used Dr. Peterschmitt`s article “Glycogen storage disease IV (GSD IV): the disease) both for the understanding of genetics and pathophysiology.

For information about Hip dysplasia I used Google and searched for “Norwegian Forest cat + hip dysplasia”. I found Dr. Susan Little`s article “Feline Hip Dysplasia”, which described well the pathophysiology of HD, as well as screening methods and treatment.

I visited Cornell University`s web page, and found an article about Feline hip dysplasia. Google book search lead me to “The complete cat`s meow” written by Darlene Arden. This book was a great source for the general understanding of HD.

Patellar luxation was already a disorder I had experience with, working at the clinic. I found additional information in Dr. Hedberg`s “Vademecum smådjur”, which is a guide for veterinarians working with dogs and cats.

The Veterinary journal`s article “Widespread retinal degenerative disease (rdAc) mutation discovered among a large number of popular cat breeds” was used as a source for some of the information about retinal degenerative disease. As well as The Veterinary Laboratory`s web page “Progressive retinal atrophy in felines” was of good source.

I was able to find information about Polycystic kidney disease on The Veterinary Laboratories web page as well. Through the Feline PKD homepage I found some more information about PKD.

I used the Google Book search to find information about Eosinophilic granuloma complex. Here I found the second edition of “Colour handbook of skin diseases of the dog and cat”. This book had its own chapter about Eosinophilic granuloma complex in cats.

3. RESULTS

3.1 BREEDING TRAITS

3.1.1 Development of breed standard

When talking about the traits of the Norwegian Forest Cat, it is important to think about its developmental history. As stated earlier, the NFC was a robust semi-wild cat living in the high mountains in Norway. The cold climate gave the cat its long and thick fur coat. Living as a wild animal, the cat had to hunt prey to eat and survive, hence its excellent skills catching fish and rodents. Climbing the mountains gave the cat its strongly built musculoskeletal system and therefore the size of the cat is quite large.

The physical characteristics previously described are important in breed standard of the NFC. Norway is very proud of our national cat breed, the Norwegian Forest Cat. Therefore it is important to keep the breeding traits pure, and to preserve its original traits.

To understand the traits of the NFC, we also need to look at the current breeding situation and strategy.

First of all, what is the breeding goal?

The breeding goal of the Norwegian Forest cat is that all cats should be bred according to the breed standards, which have been described previously.

The first NFC club, Norsk Skogkattring, held its first meeting in 1975.¹⁶ The members of the club saw a picture of a beautiful NFC called Pans Truls. After seeing Pans Truls in person, the club decided this cat should be the first model for breed standard.¹⁷

¹⁶ Norsk Skogkattring
<http://www.norskskogkattring.no/historie.htm>
Visited at 22.05.2012 at 19.00

¹⁷ Ehrhardt Tanja, Norwegische Waldkatzen : The Story of the Norwegian Forest Cat
http://www.swisskogkatt.ch/en/n_geschichte.asp
Visited at 20.05.2012 at 14.00

The breeders had to follow very strict rules, and arranged meeting to see different NFC around Europe. People wishing to breed their NFC, had to show their cats and be approved before bred as a pure NFC. The breed committee decided which cats could be registered as NFC. In 1977, the committee travelled to Paris and made a presentation to the general assembly of the Feline International Federation (FIFe). The FIFe was presented with pictures of Pans Truls, and granted championship status to the breed.¹⁸

In 1979, the first breeding pair of NFC arrived the United States, and in 1981 the first U.S litter was born.

Today, the Norwegian Forest Cat's breed standard rules are registered at FIFe's register online. Here, one can read about the breed standard and participate in shows and contests with over 229 international judges.¹⁹ The breeding programme of the NFC is given by FIFe, in cooperation with NRR (Norsk Rasekattklubbers Riksforbund).

3.1.2 Rules of breeding NFC

The most important quality when breeding a NFC, is the cat's health status. The breeders need to understand the importance of health and breed thereafter. If a cat is bred with deformities, it should not be used for further breeding, and the breeder should contact NRR to register the faults and diseases occurring. All the tomcats used in breeding programmes should be examined by a veterinarian to assure its health. The queens are not allowed to carry more than 3 litters over 24 months. The parturition should be natural, and caesarean section is seen as a fault. Other reasons for not breeding are; cryptorchidism, heart diseases, umbilical hernia, and colour not matching the breed standard rules.

¹⁸ Ehrhardt Tanja, Norwegische Waldkatzen : The Story of the Norwegian Forest Cat
http://www.swisskoggkatt.ch/en/n_geschichte.asp
Visited at 20.05.2012 at 14.00

¹⁹ FIFe Some statistics. 2012
http://fifeweb.org/wp/org/org_intro.php
Visited at 23.05.2012 at 23.00

3.2 HEREDITARY DISORDERS

3.2.1 Musculoskeletal disorders

3.2.1.1 Glycogen Storage Disease IV

Glycogen storage disease, also known as glycogenosis, is a rare inherited disorder occurring in Norwegian Forest Cats. It is an autosomal recessive trait and is the result of defects in the processing of glycogen synthesis or breakdown within muscles, liver, and other cell types.²⁰

GSD has two classes of cause: genetic and acquired. Genetic GSD is caused by any inborn error of metabolism (genetically defective enzymes) involved in these processes. In NFC, type IV has been discovered. This means that the enzyme Glycogen Branching Enzyme (GBE) is deficient, which is critical in the production of glycogen. This leads to very long unbranched glucose chains being stored in glycogen.²¹ The long unbranched molecules have a low solubility which leads to glycogen precipitation in the liver. These deposits subsequently build up in the body tissue, especially the heart, kidneys and liver.²²

GSD IV was described for the first time in the U.S 15 years ago by Professor John Fyfe.²³ He discovered neuromuscular disorders in young related Norwegian Forest cats, leading to death. These NFC were of an American population, and spread to Europe due to mixing of American and European Norwegian Forest cats. The situation was unknown in Europe and it wasn't until the late 90`s that the disease became known here as well.

²⁰ Hecquet Delphine , Glycogen Storage Disease IV (GSD IV) of the Norwegian Forest Cat in Europe History http://www.hagabackens.se/healthprogram/texter/GSD_IV.pdf
Visited 20.09 at 21.30

²¹ Shelton Loraine & Helmrich Hilary G: Heritable diseases and abnormalities in cats <http://catdnatest.org/pdf/heritable-diseases.pdf>
Visited at 26.09 at 21.40

²² Landford Veterinary Services. Glycogen Storage disease type IV http://www.langfordvets.co.uk/lab_pcr_gsd4.htm
Visited at 12.09.2012 at 21.00

²³ Hecquet Delphine , Glycogen Storage Disease IV (GSD IV) of the Norwegian Forest Cat in Europe History http://www.hagabackens.se/healthprogram/texter/GSD_IV.pdf
Visited 20.09 at 21.30

Genetics:

GSD IV have been suggested to be caused by a mutation in the GBE1 gene. It is an inherited autosomal recessive trait.²⁴ A cat can either be clear of the gene, meaning homozygous normal (genotype N/N). This means the cat is not carrying the gene and will not develop GSD IV. This cat can be mated with any other cat since it does not pass the mutation on to its offspring.

A cat having one copy of the GBE-1 gene with mutation and one copy without is therefore a heterozygous (genotype N/GSD-IV).²⁵ This cat is a carrier and will not be affected. Still, it can carry the disease on to its offsprings and should not be mated.

An affected kitten must have two GBE-1 gene copies with the mutation (genotype GSD-IV/GSD-IV).²⁶ They will always pass the mutation on to its offspring.

In order to prove the GSD-IV, we need to do a DNA-testing to find the mutated GBE-1 gene. The test can be done at any age, and can identify clinically healthy carriers as well. This method has been used to control the disease in the NFC.

Procedure: We need to do a blood sample using EDTA tubes, or special cotton swabs. The test takes about 3-5 days to perform.²⁷

This genetic screening is the only sure method to reveal the disorder. Other more unsure methods are measuring CK (creatinine kinase).²⁸ This only proves muscular lesions.

Measuring ALT will prove hepatic lesion.

²⁴ Hecquet Delphine , Glycogen Storage Disease IV (GSD IV) of the Norwegian Forest Cat in Europe History http://www.hagabackens.se/healthprogram/texter/GSD_IV.pdf
Visited 20.09 at 21.30

²⁵ Landford Veterinary Services. Glycogen Storage disease type IV http://www.langfordvets.co.uk/lab_per_gsd4.htm
Visited at 12.09.2012 at 21.00

²⁶ Landford Veterinary Services. Glycogen Storage disease type IV http://www.langfordvets.co.uk/lab_per_gsd4.htm
Visited at 12.09.2012 at 21.00

²⁷ Peterschmitt Marc, June 2008 : Glycogen Storage Disease IV (GSD IV): the disease <http://s1.e-monsite.com/2009/05/11/1421567glycogen-storage-disease-iv-pdf.pdf>
Visited 10.09.2012 at 22.30

²⁸ Peterschmitt : Glycogen Storage Disease IV (GSD IV): the disease <http://s1.e-monsite.com/2009/05/11/1421567glycogen-storage-disease-iv-pdf.pdf>
Visited 10.09.2012 at 22.30

Cats affected by GSD IV usually die only a few hours or days after birth. Some might live up till 5-10 months of age, but suddenly stop to develop and become weaker and weaker until death strikes.²⁹ The clinical signs are fever, body tremors and listlessness.³⁰

The muscles weaken and the cat will not be able to move or eat. Tetraplegia is usually a late stage clinical sign. Cause of death is usually heart attack, but if the disease is diagnosed by a veterinarian, euthanasia is recommended to avoid suffering.³¹

All cats diagnosed as a carrier, but without clinical signs, have to be neutered in order to stop spreading this disorder.

In the 1990`s it was believed that especially Amber Norwegian Forest cats were carriers of GSD IV.³² The reason for this was because GSD IV was first described in amber cats, and since the amber cats were inbred to keep its colour, they also kept the gene for GSD IV.

3.2.1.2 Hip Dysplasia (HD)

Hip dysplasia was believed to be a dog`s disease. Until recently, the disorder was found to be more frequent in cats than earlier believed.³³ Today, we know that hip dysplasia is not uncommon in cats. Several cat breeds suffers from this disorder, including the NFC.³⁴

²⁹ Peterschmitt : Glycogen Storage Disease IV (GSD IV): the disease
<http://s1.e-monsite.com/2009/05/11/1421567glycogen-storage-disease-iv-pdf.pdf>
Visited 10.09.2012 at 22.30

³⁰ Hecquet Delphine , Glycogen Storage Disease IV (GSD IV) of the Norwegian Forest Cat in Europe History
http://www.hagabackens.se/healthprogram/texter/GSD_IV.pdf
Visited 20.09 at 21.30

³¹ Peterschmitt : Glycogen Storage Disease IV (GSD IV): the disease
<http://s1.e-monsite.com/2009/05/11/1421567glycogen-storage-disease-iv-pdf.pdf>
Visited 10.09.2012 at 22.30

³² Dr. Hecquet Delphine , Glycogen Storage Disease IV (GSD IV) of the Norwegian Forest Cat in Europe
http://www.hagabackens.se/healthprogram/texter/GSD_IV.pdf
Visited 20.09 at 21.30

³³ Little Susan DVM, Feline Hip Dysplasia
http://www.winnfelinehealth.org/Pages/Feline_Hip_Dysplasia_Web.pdf
Visited at 26.09 at 22.30

³⁴ Little, Feline Hip Dysplasia
http://www.winnfelinehealth.org/Pages/Feline_Hip_Dysplasia_Web.pdf
Visited at 26.09 at 22.30

The disorder has several causes, one which might be genetic. Others such as environmental and behavioural reasons for HD, can also play an important role for disease.

Hip dysplasia is a disorder in which the ball and socket joint of hip and femur does not fit.

This allows the head of the femur to move out of the joint to some degree, and this is called subluxation. Over time, chronic changes will develop and cause degenerative joint diseases.

In NFC, the breeders need to x-ray their cats to diagnose HD. This needs to be done at an age of 2 years, when the body of the cat is fully developed.³⁵ It is important that cats diagnosed with HD, are not bred further. Since it is believed that HD is a genetic disorder, breeders need to stop breeding cats with HD no matter how successful other traits are.

Cats with HD usually show signs like weakness of hind quarters, general problems walking or jumping up and down, and a general change in activity level. Some HD can go undetected and will later progress and develop arthritis.³⁶ Since cats are more docile and calmer than dogs, they can have a better life quality with HD than dogs do. Pain killers might be necessary, even surgery can be performed. Even if a HD can be manageable, it is essential that these cats are not bred.

No single gene is thought to be responsible for hip dysplasia in either the dog or the cat, but rather a complex interplay of several genetic factors is involved.³⁷ Multiple gene pairs are involved in HD. Therefore, if two cats with no signs of HD mate, they can still get kittens with HD.

It is very important that breeders will get their NFC examined for HD. We do not want a spread of this genetic disorder.

³⁵ Little, Feline Hip Dysplasia
http://www.winnfelinehealth.org/Pages/Feline_Hip_Dysplasia_Web.pdf
Visited at 26.09 at 22.30

³⁶ Ewing, Tom. Cornell University: 2010. Hip Dysplasia
<http://www.vet.cornell.edu/fhc/healthinfo/hipdysplasia.cfm>
Visited 15.09.2012 at 21.00

³⁷ Arden, Darlene. The Complete Cat's Meow. New Jersey: Wiley Publishing, 2011. p. 144 -145.
http://books.google.no/books?id=yoPXlbQQh88C&pg=PA145&lpg=PA145&dq=norwegian+forest+cat+hip+dysplasia&source=bl&ots=1U47B3YD18&sig=cNIFY_EDC3WYN-t-Wc7YGCluCc4&hl=no&sa=X&ei=TeBuUPnDK8OA4gSKxIDoBA&ved=0CDMQ6AEwAA#v=onepage&q=norwegian%20forest%20cat%20hip%20dysplasia&f=false
Visited: 02.09.2012

The most common screening process for HD is x-ray. In order to perform x-ray of the hips, the veterinarians must have a special certification. The pictures are also submitted to the Hip Dysplasia Registry of the Orthopaedic Foundation for Animals (OFA) at the University of Missouri, Columbia, Missouri, USA. Orthopedians examine the x-rays and determine the grade of HD. OFA also reviews and grades the x-rays.

Grades of HD ³⁸

Grade 0: Normal or no HD

Grade 0/1: Borderline

Grade 1: Mild form of HD

Grade 2: Moderate form of HD

Grade 3: Severe form of HD

3.2.1.3 Patella Luxation

Although more common in the British shorthair, Abyssinian and Devon Rex, patellar luxation is recognized in the Norwegian Forest Cat as well. Luxating patella is a condition in which the patella moves out of its original physiological position. This happens when the trochlear groove is too shallow for the patella. There are two types of Patella luxation. Medial Patella Luxation (MPL) is congenital and affects cats and small dog breeds.³⁹

The second type is Lateral Patella Luxation (LPL) and is caused by trauma. The majority of patellar luxations are congenital and hereditary, although the mode of inheritance has not yet been described.⁴⁰

³⁸ Maine Game Go. Feline Hip Dysplasia, Grading of Hip Dysplasia
http://www.maineamego.eu/MAINE_EN,,maine_coon,kaj_pa_zdravje_fhd.htm
Visited at 15.09.2012 at 18.30

³⁹ Overboom-Elshoff Bianca. Norwegian forest cats. Diseases
http://www.avverden.nl/8information_diseases.htm
visited 25.08.2012 at 15.30

⁴⁰ Overboom Norwegian forest cats. Diseases
http://www.avverden.nl/8information_diseases.htm
visited 25.08.2012 at 15.30

A grading system has been developed based on the physical examination.

Grade 0: patella is in a normal position, and does not luxate during the physical examination.

Grade 1: patella will luxate when digital pressure is applied. The stifle should be extended with pressure, and will return to normal state when pressure is removed.⁴¹

Grade 2: patella easily luxates with digital pressure and remains luxated when pressure is removed. It can still be returned to the trochlear groove and will stay in place in most of the time.⁴²

Grade 3: patella is in the luxated position mostly, but can be put in the trochlear groove with pressure.⁴³

Grade 4: Patella is in luxated position all the time and cannot be returned to the trochlear groove.⁴⁴

Diagnosis is made from clinical signs and a physical examination. Clinical signs are lameness and the walking patterns might differ. Some extend their knee and hip, and some will flex the leg to try and not walk on it. The physical exams can be confirmed with x-rays which will demonstrate the patellar luxation. It is not uncommon for cats with patellar luxation to develop arthritis over time.

Grade I and II patellar luxations can be incidental findings, and asymptomatic. Grade III and IV MLP patients are usually lame.

Breeding of cats with Medial Patella Luxation is not recommended. As well as for hip dysplasia, cats below the age of 2 years old should not be tested.

⁴¹ Hedberg, Henrik: Vademecum Smådjur. Sweden: 2009. p.23.

⁴² Hedberg, Henrik: Vademecum Smådjur. Sweden: 2009. p.23.

⁴³ Hedberg, Henrik: Vademecum Smådjur. Sweden: 2009. p.23.

⁴⁴ Hedberg, Henrik: Vademecum Smådjur. Sweden: 2009. p.23.

3.2.2 Cardiovascular disorders

Hypertrophic Cardiomyopathy (HCM)

HCM is believed to be a genetic disease in the Norwegian Forest cat. Genetic mutations have been identified in Main Coon and Ragdoll, and today scientists are doing research on the NFC as well.⁴⁵ HCM is not just believed to be genetic, but also a secondary disease for hyperthyroidism. Hyperthyroidism is mostly seen in older cats. The main characteristics of HCM is left heart muscle thickening, and therefore also a decrease in chamber size. Less blood is pumped out to the body, and back-up flow will increase. As a result of this, congestion in the lungs will develop. A congestion of lungs will after time, result in right heart failure as well since it will be more resistance in the lungs. When the right heart fails, congestion in organs such as liver will develop. Heart failure can therefore lead to a multisystemic organ failure in time.

HCM tends to affect males more than females, and older cats. A cat with HCM might die suddenly and without any signs of illness. Symptoms of HCM include: Lethargy, anorexia, weight loss and heart murmur.

Diagnosis of HCM can be complex. At auscultation it might be possible to identify heart murmur and an uneven rhythm. Since hyperthyroidism might be the primary cause of HCM, it is recommended to measure T3 and T4.⁴⁶

A general standard blood sample is also important to get an insight to other organ functions. Arterial blood pressure can be measured for hypertension. More advanced methods such as ECG and Echocardiogram are frequently used. The Echo can reveal valve insufficiency and also measure the size of the heart chambers, blood load, rate and rhythm. X-ray can say something about the heart's size as it increases with HCM.

⁴⁵ Feline advisory bureau. Hypertrophic cardiomyopathy (HCM) in cats.
<http://www.fabcats.org/hcm/>
Visited at 02.10 at 20.50

⁴⁶ Cat World. Feline Hypertrophic Cardiomyopathy (HCM) – Causes, Symptoms & Treatment
<http://www.cat-world.com.au/feline-hypertrophic-cardiomyopathy>
Visited 02.10 at 20.30

Treatment of HCM consists of decreasing back up flow, and increasing forward flow. Beta-blockers decrease the heart rate, while ACE-inhibitors/ diuretics decrease the blood pressure. Digoxin makes the heart beat faster. A combination of these drugs will decrease the heart rate, increase its strength (forward flow increase and back up flow decrease). It is common that cats don't show strong clinical signs, and therefore the disease goes unnoticed.

Genetic testing has made it possible to identify HCM. One third of all tested Main Coon are positive for the mutation. The University of Veterinary Medicine in Bristol, England did genetic testing of 600 Ragdolls and found a 30% positive rate.⁴⁷

Genetic testing of cats makes it possible to find out who carries the mutation. A positive test results means that the cat is predisposed for HCM. A negative test results means that the cat does not have the one particular gene mutation. The cat can still have HCM.⁴⁸

Although the Norwegian Forest Cat has not yet been found to have the mutated gene, there is a different story with Ragdoll and Main Coon. They have been found to have defects in the same gene, the MYBPC3- gene.⁴⁹

The "HCM DNA Research Project" has been created especially for the Norwegian Forest cat.⁵⁰ It has been created for owners and breeders who are interested in the disorder, and wish to help stop spreading of the disease. The project encourages and support research for genetic testing of HCM. Their goals are to increase awareness amongst breeders, as they are important in preventing spread of the disorder.

⁴⁷ Feline advisory bureau. Hypertrophic cardiomyopathy (HCM) in cats.
<http://www.fabcats.org/hcm/>
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⁴⁸ Feline advisory bureau. Hypertrophic cardiomyopathy (HCM) in cats. Is HCM Genetic?
<http://www.fabcats.org/hcm/>
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⁴⁹ Feline advisory bureau. Hypertrophic cardiomyopathy (HCM) in cats. HCM Gene test for Ragdoll and Maine Coon
<http://www.fabcats.org/hcm/>
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⁵⁰ Norwegian Forest Cat: HCM DNA project
http://pets.dir.groups.yahoo.com/group/nfc_hcm/

HCM is quite common in the NFC. It has not yet been proven as a genetic disease, but researchers have come a long way and only time will show if the NFC has the same mutation as Ragdoll and Maine Coon.

3.2.3 Retinal Degeneration

Retinal degeneration or Retinal atrophy is a disease in which the retinal cells degenerate over time. In Norwegian Forest Cats, Abyssinians and Persians, the disease appears to be hereditary. It is an autosomal recessive disorder.⁵¹ The retinal cells are damaged and the eye is not able to transmit information regarding the light it receives. The disease usually begins with the loss of night vision.⁵² The photoreceptors in the retina will start to degenerate. At this stage, the cat will hesitate to go outside.

Retinal degeneration appears to be caused by a mutation of the rdAc- gene.⁵³ Two copies of the gene are required for loss of vision. Cats carrying only one mutated gene will not become blind. The cat's vision is normal until the age of 2 years old. The disease progress and blindness will develop fully at 3-5 year age.

Although retinal degeneration has appeared in NFC, it is not a common disease which veterinarians diagnose. The disorder in NFC is usually left unnoticed.

⁵¹ Veterinary Genetics Laboratory: Progressive Retinal Atrophy in Felines.
<http://www.vgl.ucdavis.edu/services/cat/prp.php>
Visited at 6.10.2012 at 19.50

⁵² Veterinary Genetics Laboratory: Progressive Retinal Atrophy in Felines.
<http://www.vgl.ucdavis.edu/services/cat/prp.php>
Visited at 6.10.2012 at 19.50

⁵³ M. Menotti-Raymond, V.A. David, S. Pflueger, M.E. Roelke, J. Kehler, S.J. O'Brien, K. Narfström :
"Widespread retinal degenerative disease mutation (rdAc) discovered among a large number of popular cat breeds" *The Veterinary Journal*. 2010. Volume number 186. p. 32-38.

3.2.4 Polycystic Kidney Disease

Polycystic Kidney Disease is an inherited disorder in NFC. PKD is inherited as a result of a single autosomal dominant gene abnormality.⁵⁴ Every cat with the abnormal gene will develop the disease. There are no unaffected carriers of the gene. Every cat with PKD will have the abnormal gene even if there are only a few small cysts. A cat can be affected even if only one of its parents carry the gene.

The disease is slowly progressing, and the cat can live with it for several years unnoticed. It usually develops later in life, around 7 years of age.⁵⁵ The kidneys contain cysts, which are present at birth. The size of the cysts varies from 1mm to several centimetres. Illness evolves when the cat becomes older and the cysts have grown in size.⁵⁶ The kidneys physiological function is hindered and will result in kidney failure. Clinical signs include polyuria/polydipsia, reduced appetite, enlarged kidneys, weight loss, apathy and dry hair coat.⁵⁷ If the cat develops uraemia, the breath will smell of ammonia, and vomiting and diarrhoea will be the pronounced clinical signs.

Polycystic Kidney Disease is diagnosed by ultrasound, by spotting the cysts in the kidneys. The diagnosis is said to be 98% accurate after the age of 10 months.⁵⁸

Polycystic kidney disease is a result of mutation of an autosomal dominant gene. It is easy to track and eliminate it for a breeder. If a cat is diagnosed with PKD by ultrasound, it has to be neutered in order to stop further breeding of this cat.

⁵⁴ Polycystic Kidney Disease in Cats- Causes, Symptoms & Management of Feline PKD. Visited at 04.10 at 18.30

⁵⁵ Polycystic Kidney Disease in Cats- Causes, Symptoms & Management of Feline PKD. Visited at 04.10 at 18.30

⁵⁶ Polycystic Kidney Disease in Cats- Causes, Symptoms & Management of Feline PKD. Visited at 04.10 at 18.30

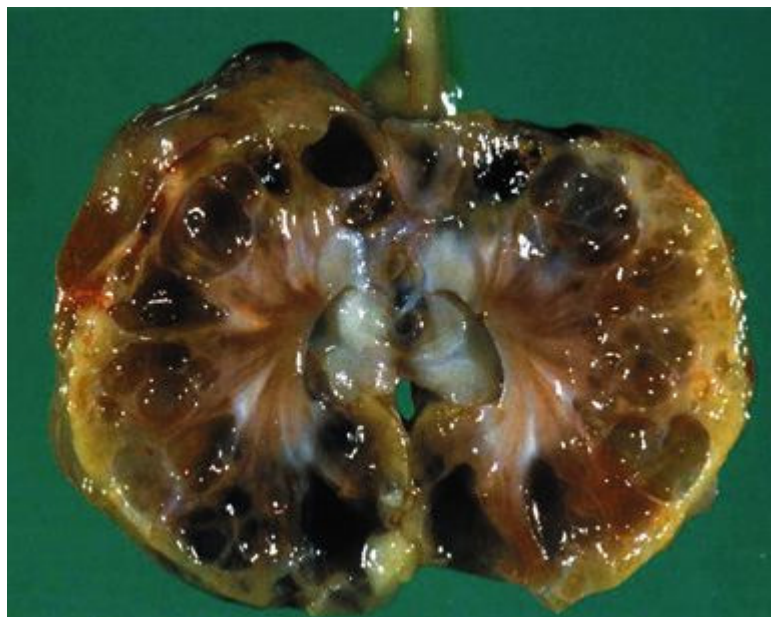
⁵⁷ Biller, David S. : Autosomal Dominant Polycystic Kidney Disease in Persians/ Exotic Shorthairs. The Feline PKD homepage. How is PKD diagnosed?
<http://www.felinepkd.com/>
Visited 04.10.2012 at 17.00

⁵⁸ Biller, David S. : Autosomal Dominant Polycystic Kidney Disease in Persians/ Exotic Shorthairs. The Feline PKD homepage. How is PKD diagnosed?
<http://www.felinepkd.com/>
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From January 2015, it is possible to diagnose PKD by a new DNA-test. This has been made possible by Dr. Leslie Lyons of the University Of California Davis, USA. The test consists of a swabbing made from the inside of the cheek. The results are 99,9 % accurate.

Norwegian Forest cats are still rated as a low risk breed for PKD, but the disease has occurred previously in the NFC. Breeders are worried that the genetic disease will spread, and are therefore encouraged to DNA-test their cats. The breeds of the highest risk are the Persian and British shorthairs.⁵⁹ No breeds of the low risk should be mated with the high risk breeds.

Photo: Polycystic kidney disease⁶⁰



⁵⁹ Leslie A. Lyons Ph.D., Assistant Professor, Department of Population Health and Reproduction, University of California, Davis. PKD1 (Polycystic Kidney Disease) in Felines
<http://www.vgl.ucdavis.edu/services/pckd1.php>. Visited 01.10 at 12.00

⁶⁰ Photo: polycystic kidney disease. <http://www.fabcats.org/breeders/infosheets/pkd/pkd.html>

3.2.5 Eosinophilic Granuloma Complex

The eosinophilic granuloma complex is a common group of skin disorders in NFC. The group consists of 3 main lesions: indolent ulcer, eosinophilic granuloma and eosinophilic plaque.⁶¹ The aetiology of these lesions is unknown.⁶² The prevalence of the disorder is quite high in NFC, and a genetic background is not unlikely.⁶³

The eosinophilic granuloma is often idiopathic, but has been associated with parasitic or allergic diseases.⁶⁴ Lesions can be found anywhere on the body and can be nodular, linear or papular. A predisposed spot for this lesion is the lower lip. The lip becomes swollen and erythematous, and the lesion is suitably called “pouting”. The linear granuloma affects the medial thigh.

The eosinophilic plaques are found on the ventral abdomen, trunk and medial thigh. The lesions are wet and ulcerated, and when coalesced they form large plaque like areas.⁶⁵ Lesions are pruritic.

Indolent ulcers are found in the philtrum of the upper lip or next to canine teeth.⁶⁶ The centrally located ulcer is surrounded by a raised periphery. This type is usually not painful or pruritic.

⁶¹ Nuttall, Tim. Harvey, Richard G. McKeever Patrick J. A colour handbook of skin diseases of dog and cat. London: Manson Publishing, 2009. p. 102-105.
http://books.google.no/books?id=CvHazimbX5oC&pg=PA309&lpg=PA309&dq=non+pruritic+granuloma+norwegian+forest+cat&source=bl&ots=DHo4EMZJle&sig=amMD356qi1pRGcpuXopp3JnTE4w&hl=en&sa=X&ei=h110UKXAEej64QTOtYCYAw&redir_esc=y#v=onepage&q=non%20pruritic%20granuloma%20norwegian%20forest%20cat&f=false
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⁶² Nuttall, Tim. Harvey, Richard G. McKeever Patrick J. A colour handbook of skin diseases of dog and cat. London: Manson Publishing, 2009. p. 102-105.
http://books.google.no/books?id=CvHazimbX5oC&pg=PA309&lpg=PA309&dq=non+pruritic+granuloma+norwegian+forest+cat&source=bl&ots=DHo4EMZJle&sig=amMD356qi1pRGcpuXopp3JnTE4w&hl=en&sa=X&ei=h110UKXAEej64QTOtYCYAw&redir_esc=y#v=onepage&q=non%20pruritic%20granuloma%20norwegian%20forest%20cat&f=false
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⁶³ Leistra WH, van Oost BA, Willemsse T. Non- pruritic granuloma in Norwegian forest cats. PubMed, 2005
<http://www.ncbi.nlm.nih.gov/pubmed/15866902>
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⁶⁴ Nuttall, Tim. Harvey, Richard G. McKeever Patrick J. A colour handbook of skin diseases of dog and cat. London: Manson Publishing, 2009. p. 102-105.

⁶⁵ Nuttall, Tim. Harvey, Richard G. McKeever Patrick J. A colour handbook of skin diseases of dog and cat. London: Manson Publishing, 2009. p. 102-105.

Eosinophilic granuloma complex is a group of well recognized lesions, but unfortunately not so well understood. Treatment is symptomatic and includes prednisolone. Most of the time, the lesions will spontaneously heal on its own. In a study of 17 related NFC, six had a linear granuloma on the medial thigh. One had an indolent ulcer and three had a granuloma on the lower lip.⁶⁷

Photo: Indolent ulcer of upper lip.⁶⁸



⁶⁶ Nuttall, Tim. Harvey, Richard G. McKeever Patrick J. A colour handbook of skin diseases of dog and cat. London: Manson Publishing, 2009. p. 102-105.

⁶⁷ Leistra WH, van Oost BA, Willemse T. Non- pruritic granuloma in Norwegian forest cats. PubMed, 2005
<http://www.ncbi.nlm.nih.gov/pubmed/15866902>
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⁶⁸ Vet Next. Eosinophilic granuloma complex. Photo.
<http://www.vetnext.com/search.php?s=aandoening&id=73323253237%20208>
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4. CONCLUSIONS

4.1 Breeding traits and history

The Norwegian forest cat's health status today can be seen in parallels with its breeding history. The cat was living in high mountains and harsh terrains. Climbing hills, catching fish in the rivers and having to survive on its own, one might say the NFC was a wild cat. The history gave the cat its unique traits. The NFC is more heavily built than other cat breeds. Its fur is thicker, making it capable of surviving in colder climates. The NFC's "wild" traits are the fundamentals of its health today.

Today the NFC is a calm and friendly breed. The NFC was domesticated in the 1930s, and this led to huge interest and fascination by humans. People wanted to start breeding the cat and protect the cat's wonderful traits. But because of World War II, cat breeding was not prioritized. The NFC was reproduced with house cats and other breeds, and a breed standard seemed far away.

In 1967, the Norwegian Association of Pedigree cats took action to preserve the breed. In the 1970s, cat fanciers started its own club called "Norsk Skogskattring". Their goal was to create and preserve a breed standard for the NFC.

How important are the consequences of mixed breeding, and has it affected genetic health of the Norwegian forest cat?

4.2 Health status today

Today, most of the NFC's genetic diseases can be tested. These methods are quite new, and more and more cat owners want to diagnose their cats. The Norwegian forest cat's health is rarely an issue, as the breed seems quite free from diseases. An important question is if the cat could be even healthier, if it wasn't for the mixed breeding during and after the WWII. The answer might be hard to find, seeing as genetic testing is quite new and few studies have been made.

Breeders today are encouraged to only breed healthy cats. Some follow the rules, and some do not. It is hard to control the breeding programs seeing as the request for the breed is increasing. Awareness is critical to prevent spread of genetic diseases.

In 2006, the Norwegian Veterinary College (NVH), NRR, Norsk Huskattforening (NHF), and Dyrebeskyttelsen (The Norwegian animal protection) cooperated on a project concerning NFC's health. Their goal was to get an overview of genetic cat diseases, including the NFC. This overview would be used to prevent further spread of disease. NFC owners in Norway were given questionnaires to fill out. Over 1000 questionnaires and PM reports were completed, and the result was as follows: The most common genetic diseases of the Norwegian forest cat in 2007 were Hypertrophic cardiomyopathy and Hip dysplasia. Following this project, the NRR created preventative programs in order to fight the diseases.

4.3 Preventative measures

Hypertrophic Cardiomyopathy

HCM can be diagnosed using doppler ultrasound and x-ray. If a cat is to be tested for HCM, it should be performed before 1 year of age. Doppler ultrasound will give an accurate picture of the heart valve thickness, and the flow of blood through the valves.

Genetic DNA-testing is also available, but only for Maine Coon and Ragdoll. NFC owners and fans are currently working on a fundraising to develop genetic testing for NFC as well. The HCM DNA research project works to create awareness around HCM. They want to promote HCM screening with Echocardiogram, and make genetic testing available. DNA screening of HCM in NFC has not yet been developed, but researchers are working on finding diagnostic DNA-methods.

The mutation causing HCM in Maine Coon will most likely not be the same as in the NFC. This means that researchers will have to start looking for a new mutation. For this, they will need more than just a swab from the inside of cheek, but also blood samples. Every known gene of the NFC has to be examined, and one gene costs \$20.000-40.000 to examine and takes 2 years. The study for HCM in NFC can take many years.

If a HCM examination is negative, the cat can be used for breeding.

Hip Dysplasia

HD affects mainly larger and heavier cats, and Maine Coon and NFC are particularly affected. In general, all cats used in breeding should be tested for HD at 2 years of age. There is no genetic test for HD, only x-ray can reveal the disease. Since HD has shown to be hereditary, it is recommended not to breed cats with this disorder. The x-ray must be taken by a HD-certified veterinarian.

GSD- IV

GSD-IV is not the most common genetic disorder in NFC. Still, testing has become easier and owners wish to diagnose their cat. DNA-testing is available, finding the mutated GBE-1 gene. Clinically healthy cats can still carry the gene and spread the disease, so testing is always recommended.

Other

Retinal degeneration, patellar luxation, eosinophilic granuloma complex and polycystic kidney disease are less common diseases in the NFC. Today, there are few preventative measures regarding these diseases. The only prevention is the owner's knowledge and interest to stop further breeding of a diseased cat.

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