THE FASCINATING COLOUR AND PATTERN GENETICS OF THE ICELANDIC SHEEP.

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It is generally known that the Icelandic sheep is one of the most colourful breeds of sheep in the world. However, not many people are familiar with how these colour variations manifest themselves. In the years that I have been breeding Icelandic sheep I have become increasingly fascinated with their wonderful colours and one of my aims in life is to breed as many of the variations in appearance as I will have time to. Even though I have been raising these delightful sheep now for almost ten years I still have not achieved several of the pattern/colour/spotting combination that this breed is capable of producing.

As most of you already know, there are basically three factors that determine the appearance of a sheep. I call these: Pattern Factor, Colour (pigment) Factor, and Spotting Factor. Technically these are referred to as existing at the A, B, and S loci of the colour genes. Several patterns exist in sheep in general but usually in each breed there is only one pattern. Samples of this are the Barbados Blackbellies which all have the Badgerface pattern, the Romanovs have a grey pattern, the Mouflon have the "black & tan" pattern, etc. The Pattern Factor in the Icelandic breed has six forms, the Colour Factor has two forms and the Spotted Factor also has two forms. Technically these forms are called alleles. I will explain each factor and its forms in turn.

THE PATTERN FACTOR - A LOCI.

The Pattern Factor is what determines the pattern on a sheep, and it is created by an off/on command. That is, colour inhibited or expresses on the various parts of the body. Inhibition of colour is dominant over expression.

1) The most dominant pattern form in the Icelandic sheep is all-colour inhibited, resulting in a ***White*** sheep.

2) The second most dominant is ***Grey Mouflon,*** recessive only to White. In Grey Mouflon, gray colour is expressed on the top of the animal, but under the jaw, down front of the neck, on the belly and legs and up the rear and under the tail is white i.e. colour inhibited. Dr. Adalsteinsson established that the Grey Mouflon pattern is caused by a gene, different from the one that causes Mouflon. However, if the Grey pattern and the Mouflon pattern (see below) are expressed simultaneously the effect will be the same as in Grey Mouflon. (No picture available)

Then come three equally dominant patterns:

A gray horned ewe.

3) The ***Gray*** has expression of colour in some hairs and not in others. That gives the looks of gray. Reduced density of colour expression also gives the look of gray since the individual hairs are actually gray or beige. In my flock I have several shades of gray, from light silver grey to dark slate gray, as well as brown and beige.

4) The ***Badgerface*** expresses colour on the face in a pattern characteristic to this pattern (a bit like a badger), on the front of the neck, on the belly extending up under the tail.

A horned black badgerface ewe

5)The ***Mouflon*** pattern is the same as descried above in Gray Mouflon,except that the colour is expressed is solid

A horned black mouflon ewe

Recessive to all the other patterns:
6) The ***Solid*** pattern. In this case the colour is expressed all over the body of the sheep

THE COLOUR FACTOR - B LOCI.

Here we have the colours. There are only two forms here: Black, which is dominant and Brown (moorit) which is recessive. This factor determines if the pattern is expressed in black or brown, such as black or brown Badgerface or black or brown Solid Colour. To have the pattern expressed in moorit, gene from both parents have to be moorit.

A moorit mouflon horned ewe

moorit badgerface polled ewe lamb

THE SPOTTING FACTOR - S LOCI.

Finally there is the Spotted Factor. Only two possibilities exist here also. Unbroken colour/pattern is dominant and results in full expression of pattern/colour combination and Broken colour/pattern which is recessive and results in white patches on top of the pattern/colour combination.
In breeds other than the Icelandic there is also a dominant black gene factor, but since this factor has not been found in the Icelandic breed I will not address it here.

A spotted black mouflon

A spotted solid moorit

HOW IT WORKS

Every sheep born gets two genes, one from each parent, for each of the three factors above. The more dominant ones will be expressed and the recessive ones will be hidden. The pattern expressed will be in the dominant colour, provided that colour is allowed to be expressed (all patterns but white). Chance seems to determine which gene the parent passes on, the dominant or the recessive. And remember that only two genes are passed on so a lamb that has four different types of grandparents only carries two of these genes. If a lamb gets a white pattern gene and a solid colour gene, that lamb will be white. But it can give a coloured offspring since the hidden solid colour gene could be the one passed on. In the case of the three equally dominant patterns (Grey, Badgerface and Mouflon) both of the two, which have been inherited, will be expressed. For example one can have Grey Badgerface, where the colour expressed in the Badgerface pattern is Grey. If Badgerface and Mouflon are expressed simultaneously colour will be inhibited where both patterns inhibit colour. Only a stripe where the colour expressions of both patterns overlap will show in the dominant colour. All the expressed patterns can hide a different pattern except the Solid Colour one. A solid colour animal has both pattern (A loci) genes solid colour. Otherwise it would have a patterned look.
The colour the pattern is expressed in is either black or brown (moorit). The brown (moorit) will only show if both genes from this factor are brown. If one of the genes is black and the other brown, the pattern of the sheep will be black since the black is dominant. So if we have a sheep with a brown (moorit) pattern we know that both colour factor genes (B loci) are brown and this sheep has only brown genes to give to its offspring.
The last factor is the spotted one. If a sheep has both genes for spots in this factor (S loci) it will be spotted on top of other factors expressed. If one or both genes are for the unbroken colour, this factor has no effect on the looks of the sheep. An interesting thing in this factor is, that a sheep that has the white pattern gene can be, from a genetic point of view, a spotted sheep. It just does not show since the pattern factor does not allow any colour to be expressed. These sheep often are exceptionally snow white. The extent of the spotting varies greatly. In my flock I have had two extreme samples of the effect of the spotting factor. A ewe I had appeared totally snow white. However, her tongue was spotted and when mated to coloured rams she always had solid coloured lambs or solid coloured spotted lambs. One of her lambs appeared solid black, but his tongue was spotted, a sure sign of homozygous spotting. I have had spotting on a grey pattern as well as on a solid colour pat-

tern and one of the Icelandic breeders in the USA had a white lamb with badgerface pattern head, i.e. spotted badgerface.
Here are a few examples to explain this further. The only sheep for which we will know exactly its colour genes by simply looking at it, is spotted moorit. Because it is spotted we know that both its spotted factor genes (S loci) are for spots since if one was for unbroken colour the sheep would be solid colour. Because it is moorit colour we know that both its colour factor genes (B loci) are for moorit. And since it is expressing colour in non-pattern fashion, all over its body, we know that it has both pattern factors (A loci) in solid colour. If this moorit spotted sheep was a ram and we mated him with a black ewe and got one black spotted lamb and one solid colour moorit lamb we would know that this black ewe has one broken-colour (spotted) gene and one non-broken gene. We also know that she has one brown colour gene and one black. The spotted black lamb got spotted genes from both parents and a brown colour from its father (he had no other colour to give) and a black colour from its mother. The solid moorit lamb got moorit from both parents and unbroken colour from its mother and broken from its father. - If this ram was used on a white ewe and we got one spotted moorit lamb and one solid black lamb we will know that this white ewe has one white pattern gene and one solid colour pattern gene. The solid colour pattern genes were passed on to both lambs and the white pattern gene was not passed on. We also know that she carries one black and one brown colour gene since one lamb got a black from her and the other one got a moorit. She also carries one broken colour gene and one non-broken gene. - If we get a solid colour lamb from two badgerface parents we know that both parents are carrying solid pattern. A solid coloured sheep mated to another solid colour will never give anything but solid colour lambs. Two white parents can give any colour/pattern lambs providing they have other genes than white. Hence we see that the ideal tester for the hidden colour genes in a flock is a spotted moorit ram.

TWO COLOURED ICELANDIC SHEEP.

When the Icelandic sheep has two colours it is caused by either the pattern genes, the spotting genes or both. The difference is, that if the two colours are caused by spotting the distribution of colour is random while if caused by pattern, the colour is in specific places. Also the spotting factor causes clear "borders" between colours while in patterns the colours gradually blend into each colour. Even though the spotting factor causes random colour distribution often the spotting appears in a manner more or less the same. Many of these types of spotting have been given descriptive names that have been used in Iceland for centuries. For example if the spotting is on the feet alone reaching up to the dewclaws the sheep is said to be "socked" (leistott). If the whole legs are spotted the sheep is "hosed" (hosott). If the rear half is all white and the front is coloured it is "hooded" (hottott) and if head and back are coloured it is "coated" (kapott). I know more than 25 such names and I am no expert.
One more thing about the colour. The colour in the Colour Factor (B-loci) is caused by pigment called eumelanin (the black and moorit). There is also pigment called phaeomelanin which is described as tan, yellow or sometimes red. These pigments often appear where the pattern inhibits the eumelanin expression. In sheep white by pattern, this tan (it is called yellow in Iceland) is often on head, tail and feet. On lambs it is often very pronounced but it usually diminishes when the sheep grow older. This pigment is fairly common on head, feet and tail (but not in the fleece) in the Icelandic breed since, for a long time earlier this century, it was believed that sheep with this tan had better meat conformation. Since the breed has primarily been bred for meat for the last 100 years this tan got very common in the breed.
I would like to end by referring the reader to an excellent two part article by Janne Rosecrans in BSN issues 63 and 64. That article, along with a personal tutoring from a friend, Christine Duff-English, made the confusion of colour genetics into a clear, simple and fascinating subject for me.
Note. The name of one of the forms of the Pattern Factors, the Grey, can be very confusing. When referring to the pattern form it does not necessarily mean the colour grey, because if the sheep is homozygous for moorit the actual colour of this pattern is beige or light brown. If the sheep has a black form on the B-loci then the pattern Grey will be grey in colour. I also understand that the proper name for the Mouflon pattern is "Black and Tan". I do have a bit of a problem with that since that pattern can be, as well as "Black & Tan", "Moorit & Tan", "Grey and Tan" and "Beige and Tan". That is why I prefer to use the term "Mouflon" for that particular pattern.

A gray ewe with heavy pheomelanin

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