The Chocolate and Lilac Colours in the Abyssinian and Somali Breeds

I wanted this article[1] to be both a presentation and a reflection on what are the chocolate and lilac colours. These colours are considered as new colours in the abyssinian and somali breeds, but remain within the wood-type colour range which suits them so well !

After a short historical summary of how these colours first appeared in the breed, and an overview of which colours are recognised by the different cat federations in the world, I suggest some hypotheses of the underlying genetics to explain the range of colour variation.

1 A Brief History

In the 1970's, some breeders wanted to extend the range of basic colours found in the abyssinian breed (ruddy, sorrel, then their diluted counterparts, respectively blue and fawn). Some cats called chocolate did exist in other breeds, and in non-agouti (*solid*) cats this colour appears as a beautiful dark brown. The diluted version of the chocolate colour is called lilac, or lavender. The colour of a chocolate abyssinian or somali appears as an intermediate between ruddy and sorrel, with its ticking not being black as in a ruddy or red like in a sorrel, but more dark brown (like a dark chocolate with at least 50% cocoa) and an apricot-coloured undercoat. Similarly, the hue of a lilac abyssinian or somali can be described as intermediate between blue and fawn. One finds the terms dove grey or mushroom coloured in the descriptions: the colour is a fairly dark beige with some lavender/purple tinge.

For breeders to achieve this goal, since chocolate is a colour which is fairly common among siamese, it is often the mating of a chocolate siamese with an abyssinian who was used at the start. Among the different outcrosses, one of the most famous is the mating of Lady Fayre[2], a chocolate siamese female carrying dilution with a sorrel abyssinian, Barentu Red Rudy (sic) born in 1971. This mating resulted in the birth of a chocolate female, Arboreal Chocolate Katrina, who was used to introduce the chocolate colour in abyssinian lines. Most cats carrying the Manot affix today in the UK (Carol Ottey), or the Alexy affix in the USA (Bruce Alexy) are offspring of this mating. Looking at their pedigree, one may keep track of the chocolate over 10 to 15 generations.

Other similar outcrosses were also done elsewhere, e.g. in France and in the Netherlands. In France, this was mostly the achievement of the Bethsabée (Davaine-Chevaux family)

[2] the pedigree of all cats cited in this article may be found on ERoS, on-line pedigree database with url http://www.somali.asso.fr/eros/

Figure 1: chocolate somali female (News de Bethsabée, aka Nougatine, 3 months old)

cattery who married a chocolate siamese female to a sorrel somali to obtain a chocolate female, whose son Et un Chocolat Un de Bethsabée is the founding ancestor of the chocolate somalis from this line.

In parallel, in the Netherlands, one may cite the mating of a chocolate burmese stud, Hunter von der Ruhr with a sorrel abyssinian female, which gave birth to a chocolate female who is the founding queen of other abyssinian and somalis not having in their pedigrees (as far as we can track!) any other chocolate ancestor.

These examples are not exhaustive. In particular, in some abyssinian or somali lines, there are cats which are recognised by the feline judges as being chocolate (resp. lilac), but whose pedigree only contains ruddy and sorrel cats. This may be explained in different ways. One possibility takes into account the fact that black (ruddy) is dominant over chocolate; hence chocolate may remain hidden for generations before a chocolate cat appears (recessive is for ever!). Of course, one of the ruddy ancestors must have been a chocolate carrier... Another interpretation would be that some cats registered as sorrel be in fact chocolate. Or... but let's leave the other interpretations for the genetics section !

2 Chocolate and Lilac Recognition by the Different Federations

In France, the LOOF officially recognises chocolate and lilac abyssinians and somalis [3]. But this is far from being the case in all cat federations throughout the world! Let's review the colours recognised for championship in CFA (USA), FIFe, TICA (USA), GCCF (UK) and LOOF (F), order being from the most restrictive to the less restrictive organisations.

The CFA (Cat Fancier's Association, Inc.), which presents itself as the World's largest registry of pedigreed cats, recognises abyssinians and somalis in only 4 colours: [4] *ruddy*, *red* (nothing to do with the sex-linked red), *blue* and *fawn*. Other colours, including chocolate and lilac, which are still very seldom found in the USA, are disqualified and cannot be registered at all.

The FIFe (Fédération Internationale Féline) accepts twice as many colours as CFA. In addition to the 4 colours above, their silver (white undercoat) varieties are also officially recognised. Here as well, no chocolate or lilac in championship class ! The EMS (Easy Mind System) coding used by FIFe, however, covers these colours, since they are recognised for some other breeds. The following table summarises the EMS codes used by FIFe for colours other than sex-linked ones.

	non silver		silver	
ruddy	ABY/SOM n		ABY/SOM ns	black silver
sorrel	ABY/SOM o		ABY/SOM os	sorrel silver
blue	ABY/SOM a		ABY/SOM as	blue silver
fawn	ABY/SOM p		ABY/SOM ps	beige-fawn silver
chocolate	ABY/SOM b		ABY/SOM bs	chocolate silver
lilac	ABY/SOM c		ABY/SOM cs	lilac silver

TICA (The International Cat Association) [5] has been recognising for a few months the 12 colours of the above table, i.e. the three basic colours (ruddy, chocolate, sorrel), their diluted variations (blue, lilac, fawn) and the silver varieties corresponding to these 6 colours. Cats of any of these colours may participate in Championship competition.

Finally, LOOF in France as well as GCCF in the UK do recognise... 28 colours for abyssinians and somalis ! Describing them all would go far beyond the scope of this article, since in addition to the 12 colours already cited, one must also consider sex-linked red, its cream dilution, the corresponding silver varieties and all the tortie combinations resulting

[3] the LOOF standards can be found at http://www.loof.asso.fr/lesstandards.php
[4] CFA standards can be found at http://www.cfainc.org/breeds/standards/standards-index.html
[5] TICA standards can be found at http://www.tica.org/standards.htm

from a patchwork between the colours of the table and red (or cream for diluted cats). This makes a total of $(2 \times 12) + 4 = 28$ colours ! Each one has its own EMS code, of course.

3 Debate on the Underlying Genetics

Almost all books dealing with feline genetics will present the same theory to explain the transmission of basic colours between a pair of cats and their offspring. I will start by presenting this theory, for those who don't know it already. Then I shall discuss a few alternatives.

In the nucleus of every cell in a cat, there are 19 pairs of chromosomes, except in the gametes who have half this number (19 chromosomes). Every chromosome carries thousands of genes controlling the synthesis of the various proteins needed by the cell. The position of a gene, independently of its contents, is called a locus, and for each locus several possible expressions of the gene exist, which are called alleles. For example, on the hair length locus, one may find either of the two known alleles shorthair (generally noted L) or longhair (generally noted l). Since every cat carries two occurrences of each gene (one coming from the sperm cell of his sire, one coming from the ovule of his dam), three possible combinations exist: LL, Ll and ll. The look of the cat (his phenotype) is determined by this combination. It can be guessed that a LL cat will be a shorthair cat, whereas a ll cat will be a longhair cat. But what about a Ll cat ?

This is when the concept of dominant allele and recessive allele comes in. To just go on with the hair length example, one may say that the shorthair allele is dominant over the longhair allele, which means that a Ll cat will have short hair. The mating between an abyssinian (LL)and a somali (ll) therefore produces offspring known as variant abyssinians (Ll). These offspring are very close to abyssinians in their look, but only somali breeders are potentially interested in them in their breeding programs, hence the more logical name shorthair somali used in several countries.

But let's come back to our colours ! The dominant theory assumes that, on the basic colour locus, usually referred to as B, three known alleles exist:

- B = black
- b = chocolate, b standing for "brown"
- bl = cinnamon, l standing for light (brown)

B is dominant over the other two, and b is (possibly not fully) dominant over bl. This means that a ruddy (black) cat may genotypically be BB, Bb or Bbl (i.e. this cat may carry chocolate or cinnamon — we remain in a gourmet vocabulary...), that a chocolate cat may genotypically be bb or bbl (i.e. this cat may carry cinnamon), but that a sorrel (cinnamon)

cat may only have one genotype: blbl. Indeed, if one of the two alleles carried by this cat was B or b, the cat would be ruddy or chocolate !

In practice, between a real chocolate cat and a real sorrel cat, a continuum of colour variation exists. This also holds true for the silver varieties, the diluted ones (lilac vs fawn), and the silver diluted ones. So, how can this be explained ? Of course, one often hears that the variability results from the action of polygens. This means that, instead of having a character expressing itself according to one of two very different modes, a whole series of other characters intervenes to change a bit the look of the cat, which cannot be modelled easily as bi-modal recessive and dominant genes.

Figure 2: Silver lilac somali female (Samiole de la Chacolaterie, aka Bouboule)

No colour ambiguity exists between a ruddy and a sorrel cat. Even if certain ruddy cats have an undercoat which is much warmer than others, or have the black ticking extending further down the flanks, they will never be confused with a sorrel cat (at least when you see the cats in real life, since pictures may be very misleading). Similarly, I do not know of any ambiguity between a ruddy cat and a chocolate cat. But I already met cats which are sorrel according to their pedigree, and which are much more on the chocolate side than cats registered as such, and reciprocally! Similar cases exist between lilac and fawn cats. A teach-in session on abyssinian and somali coat colours, which was organised in the Netherlands in September 2000, and to whom I had been participating, was extremely interesting with regards to this. The organising club had attempted during this one-day session to bring together at least one abyssinian and one somali of each of the 12 non sex-linked colours,

enabling their owners and 4 international judges to discuss, learn and compare. It was particularly useful since breeders and judges often report hesitations between sorrel and chocolate (chorrel cats...), or, in the dilute varieties, where the confusion may be even more frequent, lifawn cats...

Of course, some bias may result from the rules established by the registries themselves. The fact that the chocolate colour is not recognised (or was only recently recognised) by many feline registries in the abyssinian and somali breeds may have resulted in several breeders registering their cats as sorrel (resp. fawn) when they should have been labelled chocolate (resp. lilac), should these colour be permitted. On the day when these colours become fully recognised for championship, some breeders then ask for a change of colour on their cat's pedigree and possibly on some of his/her ancestors' pedigree. This case happened in TICA not long ago, when chocolate and lilac abyssinians and somalis were approved for championship status. However, the judges will have accumulated experience by judging a pool of sorrel (resp. fawn) cats, some of which were indeed chocolate (resp. lilac). And the task is quite hard when colours are close!

This closeness between sorrel and chocolate, combined with the fact that the only 100% chocolate cats (i.e. judged as such without ambiguity compared to sorrel) I have had the opportunity to breed or meet always had a pale (cold-coloured) undercoat, has led me to develop an alternative hypothesis for the underlying genetics. Why couldn't the basic colour allele be the same for chocolate and sorrel cats, the variation stemming from other genes, such as those controlling the amount of rufus or the blurring of the coat pattern ? Abyssinians have been selectively bred for more than a century (many generations indeed!) for a warmer and warmer undercoat, as well as for less and less tabby markings, hence more blurring of the residual pattern, in particular for necklaces and stripes on the front paws. What if a side effect of this selection was to get the chocolate ticking lighter, up to the point where it becomes so different from other breeds that this would warrant its specific name ?

Another issue supports this alternative hypothesis: though spontaneous mutations may appear all the time, very few are stable enough to propagate noticeably among a population. Between two models, the one requiring less mutations is therefore to be preferred. In our case, the chocolate mutation changing the B allele into a b allele seems to have a unique origin, in the pool of pointed cats in South-East Asia. Chocolate Burmese, Persians, Sacred Birmans, Havana Browns or Chocolate Yorks have inherited from this allele, directly or indirectly, from siamese cats. In parallel, the sorrel colour (resulting, in the canonical approach, from the mutation changing the B allele into a bl allele) would have started only in the abyssinian breed. Other cinnamon cats (like orientals for instance) have indeed been produced by outcrosses with abyssinians. So why wouldn't there be a single mutation, transforming the original B allele into a b allele, with abyssinians having inherited from this mutation in their gene pool, but having been selected over generations to enhance the undercoat colour while as a side effect making the ticking look a bit paler ? Most breed standards for abyssinians and somalis mention a chocolate ticking for sorrel cats. Isn't this a leftover of what the cats really looked like years ago ? The warmer the undercoat, the more the dark bands of a ticked cat (if in the same colour range) appears reddish and light. I vividly remember a litter of

Figure 3: Prawlin, chocolate somali female with her sister Pyrite, chocolate silver somali

two somalis (see picture), one being chocolate (Prawlin de la Chacolaterie), the other being chocolate silver (Pyrite de la Chacolaterie), whose appearance was really like a brown one and a grey one (with a little bit of simplification...). When looking closer at them, the colour of the ticking (and of hair at the tip of the tail, for instance) was absolutely identical. This shows that the undercoat colour changes completely our perception of the basic colour, like in those optical illusions where a grey circle will be perceived as darker or lighter depending on its surroundings.

Of course, my alternative hypothesis is by no means proved. But, imho, nothing enables to dismiss it compared to the canonical one today. A DNA test under validation by the California University at Davis should soon enable to identify cats who carry the chocolate mutation (change of the B allele into b). Maybe this test will contribute to shed light on our issue... Do our sorrel abyssinians and somalis carry the same b allele on the B locus as their chocolate siamese cousins or do they carry a different allele ?

Whatever the answer, it will be very interesting to have it. In the meantime, should you have unbiased arguments in favour of one theory or another, please feel free to express them so that we can all progress in our understanding.

4 Conclusion, or Why did I get interested in these Colours

As you may have noticed, when I start talking about feline genetics, I can't stop! Thanks to my scientific background, and having always been interested by biology (though my profession is in a very different domain), I am thrilled by the questions raised by feline genetics. But I had no particular reason to bear attention to the chocolate or lilac colours until one day, being at last able to adopt the cat I had been dreaming of for years, I fell in love with a little somali female... can you guess which colour she was? Chocolate of course! (it is well known that chocolate is great to fight off the blues...)

Unfortunately, NOUGATINE (it was her pet name) walked away much too soon to look for other colours on the other side of the rainbow. We had named our small family breeding la Chacolaterie for her [6] and to honour the memory of everything she brought to us I wanted to go on to better understand this colour.

I think I've written long enough for now. I hope that you found some interest in this article. Please make your complements and suggestions in return!

Babette PAUTET

[6] the web site of la Chacolaterie is at http://perso.wanadoo.fr/cell.sys/perso/bonjour.htm