

The colourful C-locus

BY ANNALIE PRINSLOO (APRIL 2015)

Origin

THE ALLELES OF THE C GENE:

THE PINK EYED WHITE ALLELE (c)

Pink eyed white, also known as albino, is one of the oldest fancy rat varieties available today. Pink eyed white occurs in many strains of laboratory rats including: “Lewis”; “Sprague Dawley”; “Wistar”; “Lou-Nu” (a hairless PEW); and “SHR” (Janvier Labs, 2015). Within the science community breeding experiments were carried out on pink eyed white as far back as 1877 (Robinson, 1965).



Dumbo pink eyed white doe
(c/c)

Mary Douglas, the mother of the rat fancy, stated that a pair of pink eyed whites was introduced to Great Britain by a travelling entertainer around the year 1800. Pink eyed white rats were sold as pets in the period 1840 to 1860. Beatrix Potter dedicated her book “Samuel Whiskers” to her pet pink eyed white rat in 1908. Pink eyed white appeared in the show standards of the National Mouse Club in 1901. Pink eyed white was taken over by the NFRS in 1976 (Mays, 1997 & Royer, 1998).

THE HIMALAYAN ALLELE (c^h)



Seal point Siamese self buck
(a/a c^h/c^h)

The Himalayan allele originated from a laboratory in Orly, France* in 1972 (Mays, 1997). From France the Himalayan found their way to England and the rat fancy through a venture where the NFRS had an opportunity to acquire Himalayan through an import working together with a laboratory in Surrey, England. Three pairs were imported from France in 1978 and the first offspring of each pair was given to the NFRS by the laboratory in Surrey which kept the original stock. In 1979 Siamese (c^h/c^h) was bred from the Himalayans (c^h/c). In 1983 fanciers in Southern California, USA imported eight

Siamese rats from England to the United States of America (Mays, 1997 & Royer, 1996). The Himalayan allele was scientifically described in 2010 (Kuramoto, *et al.* 2010).

* This is the reason why we sometimes refer to Himalayan and Siamese as “French Himalayan” and “French Siamese” in South Africa (this is so that we can distinguish them from our local Himalayan and Siamese varieties called “Sable Himalayan” and “Sable Siamese”).

THE SABLE SIAMESE ALLELE (c^s)



Dumbo Seal point Sable
Siamese self buck
(a/a c^(s)/c^(s))

Sable Siamese is a purely South African allele of the C-locus which was first seen in petshops in the 1990's. To date no sable Siamese have been exported yet to other countries making South Africa still the only country where one can find them. Sable Siamese is largely unknown to overseas rat communities and are therefore not mentioned anywhere on foreign websites. Sable Siamese has not been scientifically described yet.

My encounter with Sable Siamese:

In 1997 I saw the first Sable Siamese in a pet shop in Pretoria. I bought the 4 rats and started my Sable Siamese breeding lines from them. I tried to inquire at the pet shop from where these rats came from and they said Johannesburg.

Three of my first Sable Siameses I found in a petshop:



Seal point Sable Himalayan Berkshire doe

Seal point Sable Siamese Berkshire doe

Seal point Sable Siamese Berkshire buck



Lady, my first Seal point Sable
Himalayan berkshire doe as an
adult (she is the first rat in the picture above this one)

It was only in 2006 when I saw my first living examples of "French" Himalayan (c^h/c) (MS Orla and MS Odin) and a black eyed "French" Siamese (c^h/c^h Be/-) (MS Devon) that I knew that our Siamese were unique. Up to 2006 I just called them Siamese. Since I could not rename the Siamese mutation (from the c^h allele) I had to come up with a name for the South African Siamese. I got the idea of Sable Siamese from a rabbit mutation after searching for similar mutations in other species.

The three himalayan allele (c^h) based rats which were imported from the USA in 2006:



MS Odin

(Dumbo Seal point Himalayan Berkshire buck)

MS Orla

(Dumbo Seal point Himalayan Berkshire doe)

MS Devon

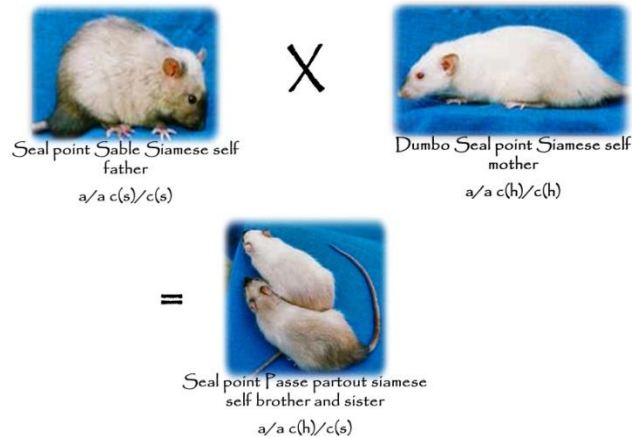
(Black eyed Seal point Siamese self buck)

When Liezel and I bred enough Siamese (c^h/c^h) and Himalayan (c^h/c), I set out on an experimental breeding program for Connie Perez to determine the genetics of the Sable Siamese (c^s/c^s). I crossed Sable Siamese (c^s/c^s) with Siamese (c^h/c^h) and got 100% "PPO" Siamese (c^s/c^h) kittens in the litter. These F1 kittens (called *passee-partout** Siamese) looked a bit like both Siamese and Sable Siamese showing that Sable Siamese was a new allele on the C locus. I named the allele c^s to avoid confusion when writing out Siamese rat genetics. Siamese is known as c^h . I posted my initial findings on the Yahoo rat genetics group on 23 November 2006. Today Sable Siamese is still one of my favourite varieties and I am continuing breeding and researching this mutation in comparison with the c ; c^h ; Be and Bu.

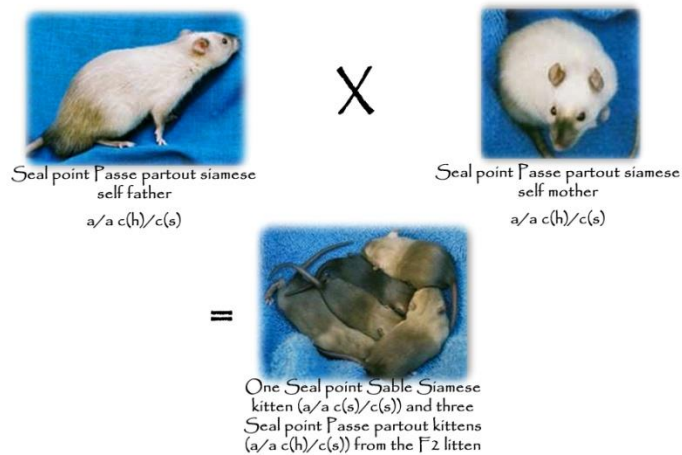
*A French word meaning master key, pronounced paspa:'tu: Used in genetics to refer to a phenotype expressing the characteristics of both parent genotypes simultaneously. A *passee-partout* is the masterkey for two alleles.

The Himalayan allele (c^h) and the Sable Siamese allele (c^s) test crosses:

The F1 cross was between a Seal point Sable Siamese buck and a Seal point Siamese doe:



All the kittens were Seal point Passee partout Siameses and a brother and sister shown below was crossed:



The F2 litter had all three types of Siameses:

Sable siamese (c^s/c^s); Passee partout Siamese (c^h/c^s) and Siamese (c^h/c^h)

THE BLACK EYED GENE (BE GENE)



Ivory self doe
(a/a Be/Be c/c)

In 1998, a “white rat with black eyes” named The Milkman was born in a laboratory at the Edinburgh University in Scotland. The Milkman along with his sister, Crystal was given to a breeder named Donald Dickson in Scotland. Crystal was described as a “poor cinnamon” colour, but today we know it as biscuit (A/- c/c Be/Be Bu/bu - Crystal was an agouti based biscuit). The Milkman was an ivory rat (a/a c/c Be/Be bu/bu). The Milkman and Crystal were bred together and produced Black eyed cream (A/- c/c Be/Be bu/bu) and biscuit (A/- c/c Be/Be Bu/bu) kittens. The Milkman was also crossed with a blue rat which carried Siamese which gave black and

Black eyed Himalayan (A/a c^h/c Be/Be) kittens. Veronica Simmons went to Scotland and bought some of these kittens and introduced them to England. In November 2004, Burmese, Black eyed Cream, and Black eyed Himalayan & Black eyed Siamese rats were imported to the USA (Robbins, 2007). The Black eyed gene was scientifically described in 2010 (Kuramoto, *et al.* 2010).

THE BURMESE GENE (BU GENE)



Wheaten biscuit self buck
(A/- Bu/- c/c)

The history of the Burmese gene is tied with the discovery of the black eyed gene. The rat named Crystal described in the previous paragraph is the mother of all Burmese rats. She was an agouti based biscuit or wheaten biscuit (A/- c/c Be/Be Bu/bu) which is how the Burmese gene expresses on a pink eyed white background. Descendants from Crystal were crossed with Siamese to make the Burmese variety we know today.

South African History

THE PINK EYED WHITE ALLELE (c)

Pink eyed white rats have been available in the South African pet trade from at least the 1950's. It is speculated that they might be from laboratory origin originally, being later introduced into the pet trade, but there is no proof if this is true or not (Ratanooga forum post started 24 March 2015).

THE HIMALAYAN ALLELE (c^h)

The Himalayan allele originated from the imported rats MS Orla and MS Odin which were imported in 2006 by Liezel Hattingh. Both MS Orla and MS Odin were themselves Seal point Himalayans (a/a

c^h/c). The Himalayan allele also appeared in some of the other imported lines, like descendants from the MS Bonnie x MS Clyde cross.



Seal point Sable Siamese
berkshire doe
($a/a c(s)/c(s)$)

MS Devon was crossed with MS Freya, a Burmese female, and kittens of that litter was distributed to various breeders to establish the gene in South Africa.

THE BURMESE GENE (Bu gene)

All South African Burmese rats came from the Burmese female MS Freya described above. Kittens from the MS Devon x MS Freya litter were distributed to various breeders and all our Burmese rats are descendants of the Burmese kittens of that litter.

Description of the variety

PINK EYED WHITE (c/c)

“A pure white colour throughout. Eye colour is red.” -- S.A.R.F.C. Standards

A pink eyed white is simply white. Since pink eyed whites have no pigment in their fur they cannot have any colour faults caused by the mutation. Their coats can, however, easily stain for instance from the bedding on which they are kept. Many pink eyed whites have a yellowish stain and it is worse in older male pink eyed whites.



Pink eyed white buck
(c/c)



Pink eyed white doe
(c/c)



Pink eyed white kitten
(c/c)

THE SABLE SIAMESE ALLELE (c^s)

The Sable Siamese allele is an allele of the C-locus that spontaneously occurred in South African pet shop rats. Today Sable Siamese is widely distributed across the country and one of the most common mutations found in pet shops.

THE BLACK EYED GENE (Be gene)

All the black eyed rats in South Africa originate from one of the rats imported in 2006. MS Devon was a black eyed Siamese male rat that expressed the black eyed gene.



Brown Burmese Berkshire doe
($a/a Bu/- c(s)/c(s)$)

THE HIMALAYAN ALLELE (c^h); SABLE SIAMESE ALLELE (c^s) AND THEIR INTERACTION WITH THE PINK EYED WHITE ALLELE (c)

The Himalayan and the Sable Siamese alleles are both temperature sensitive and will appear darker and more shaded on colder weather than in warm weather. That is why Siamese kittens born in the winter look darker and better shaded than Siamese kittens born in the summer months. This temperature sensitive effect is known as acromelanism and is also the reason why the extremities of the body, which is the cooler areas on the body, is darker than the rest of the body (Royer, 1996).

BLACK BASED COLOURS:

SEAL POINT HIMALAYAN ($a/a c^h/c$)

Body colour is white. The points* are a light sepia colour. There is no shading from points to body colour. Eye colour is red (like a pink eyed white rat's eyes). Kittens are born white and start to develop points at about 6 weeks old.



Seal point Himalayan self buck
($a/a c^h/c$)



Seal point Himalayan self kitten
($a/a c^h/c$)

SEAL POINT SIAMESE ($a/a c^h/c^h$)

Body colour is medium beige. The points* are a sepia colour. There is gradual shading from the point at the tail base into the body colour. Eye colour is dark red (a bit darker than a pink eyed white rat's eyes). Kittens are born a brown-beige colour and at 6 weeks old the colour will fade as the rat moulds into his adult coat to reveal a light body with dark points.



Dumbo Seal point Siamese self buck
($a/a c^h/c^h$)



Dumbo Seal point Siamese self kitten
($a/a c^h/c^h$)

SEAL POINT SABLE HIMALAYAN ($a/a c^s/c$)

Body colour is light beige. The points* are a dark brown colour. There is gradual shading from the point at the tail base into the body colour (Sable Himalayans have shading!). Eye colour is ruby (darker than a seal point siamese). Kittens are born a medium brown-grey colour and at 6 weeks old the colour will fade as the rat moulds into his adult coat to reveal a light body with dark points.



Seal point Sable Himalayan self buck
(a/a c(s)/c)



Seal point Sable Himalayan self doe
(a/a c(s)/c)



Seal point Sable Himalayan Berkshire kitten
(a/a c(s)/c)

SEAL POINT SABLE SIAMESE (a/a c^s/c^s)

Body colour is rich beige. The points* are a sable brown colour. There is gradual shading from the point at the tail base into the body colour (shading is much more intense than in seal point Siamese and Sable seal point Himalayans). Eye colour is dark ruby (almost appear black in poor light). Kittens are born a dark brown-grey colour and at 6 weeks old the colour will fade as the rat moulds into his adult coat to reveal a light body with dark points.



Seal point Sable Siamese self buck
(a/a c(s)/c(s))



Dumbo Seal point Sable Siamese self doe
(a/a c(s)/c(s))



Seal point Sable Siamese self kitten
(a/a c(s)/c(s))

SEAL POINT PASSE-PARTOUT SIAMESE (a/a c^h/c^s)

Body colour is medium beige. The points* are a sable brown colour. There is gradual shading from the point at the tail base into the body colour. Eye colour is dark red. Kittens are born a grey-brown colour which are lighter over the shoulders and at 6 weeks old the colour will fade as the rat moulds into his adult coat to reveal a light body with dark points.



Seal point Passe partout Siamese self buck
(a/a c(h)/c(s))



Seal point Passe partout Siamese self kittens (and one Seal point Sable siamese self kitten - the dark one)
(a/a c(h)/c(s))

AGOUTI BASED COLOURS:

AGOUTI POINT HIMALAYAN (A/-c^h/c)

Body colour is white. The points* are a creamy brown colour with ticking (especially noted at tail base). There is no shading from points to body colour. Eye colour is red (like a pink eyed white rat's eyes). Kittens are born white and start to develop points at about 6 weeks old.



Dumbo Agouti point Himalayan
self doe
(A/-c(h)/c)



Dumbo Agouti point Himalayan
self kitten
(A/-c(h)/c)

AGOUTI POINT SIAMESE (A/-c^h/c^h)

Body colour is light beige. The points* are a mealy agouti colour with ticking (especially noted at tail base). There is gradual shading from the point at the tail base into the body colour. Eye colour is dark red (a bit darker than a pink eyed white rat's eyes). Kittens are born a beige-agouti colour and at 6 weeks old the colour will fade as the rat moulds into his adult coat to reveal a light body with dark points.

AGOUTI POINT SABLE HIMALAYAN (A/-c^s/c)

Body colour is light cream. The points* are an agouti-brown colour with ticking (especially noted at tail base and on nose point). There is gradual shading from the point at the tail base into the body colour (Sable Himalayans have shading!). Eye colour is ruby (darker than a agouti point siamese). Kittens are born a medium light agouti-grey colour and at 6 weeks old the colour will fade as the rat moulds into his adult coat to reveal a light body with dark points.



Dumbo Agouti point Sable
Himalayan self buck
(A/-c(s)/c)



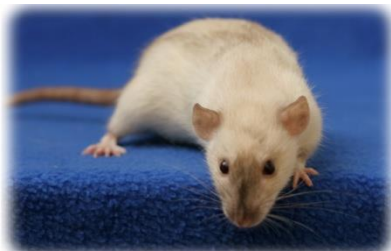
Agouti point Sable Himalayan
self doe
(A/-c(s)/c)



Dumbo Agouti point Sable
Himalayan Berkshire kitten
(A/-c(s)/c)

AGOUTI POINT SABLE SIAMESE (A/-c^s/c^s)

Body colour is mealy beige. The points* are a dark agouti colour. There is gradual shading from the point at the tail base into the body colour (shading is much more intense than in agouti point Siamese and sable agouti point Himalayans). Eye colour is dark ruby (almost appear black in poor light). Kittens are born a dark mealy-agouti colour and at 6 weeks old the colour will fade as the rat moulds into his adult coat to reveal a light body with dark points.



Dumbo Agouti point Sable
Siamese Berkshire doe
(A/-c(s)/c(s))



Dumbo Agouti point Sable
Siamese self kitten
(A/-c(s)/c(s))

AGOUTI POINT PASSE-PARTOUT SIAMESE (A/-c^h/c^s)

Body colour is medium beige. The points* are a dark agouti colour. There is gradual shading from the point at the tail base into the body colour. Eye colour is dark red. Kittens are born a grey-agouti colour and at 6 weeks old the colour will fade as the rat moulds into his adult coat to reveal a light body with dark points.

*Which include nose, ears, front legs, hind legs and tail.

HOW TO DISTINGUISH BETWEEN DIFFERENT KINDS OF SIAMESES AND HOW TO BREED THEM FOR SHOW QUALITY

It can be hard to distinguish the different kinds of Siamese rats when they are young. The coat colour of a young Siamese rat might vary and even diet has an influence on a young kitten's initial colour. Eye colour is a more reliable indicator of the kind of Siamese you have, but you will have to know exactly how each type of Siamese rat's eyes should look like before you can know for sure. What complicates matters severely is when you have black eyed Siamese rats. They are almost impossible to distinguish and even black eyed Sable Siamese baby rats compared to Burmese baby rats are virtually indistinguishable. One will have to wait until the kittens fade to know for sure what colour you have.

To breed all kinds of Siamese rats for show quality one obviously has to look at temperament and conformation. With regards to picking good colour, one traditionally picks the darkest Siamese kittens in the litter. These are the most likely to become the best Siameses but sometimes even a lighter kitten becomes a beautiful Siamese when grown up. Show quality Siamese rats should never have white on the body so do not breed markings into your Siamese lines if aiming for good Siamese rats. Use only self rats and outcross with very good black selfs to remove white toes and tailtips from Siamese lines.

THE BURMESE GENE (bu gene) AND THE RESULTING COLOURS

The Burmese gene is assumed to be a separate gene affecting the C locus. It is a dominant gene, and it seems that only one copy of the gene is needed to get the "Burmese effect". It appears that when there are two copies of the Burmese gene, one still has viable healthy rats unlike in many other dominant genes. Sadly the Burmese gene is not yet scientifically described so fanciers still have to guess at how it exactly works.

The Burmese gene results in much less severe lightening of the coat caused by the C-locus alleles resulting in darker rats. The coat will appear brown instead of black on a black based rat and washed out on an agouti based rat.

Another peculiar thing about the Burmese gene is that it sometimes results in rats with a marbled effect. These rats have pale coloured spots somewhere on their bodies and especially on the face. It is not known genetically what causes this effect and how it inherits.



Brown Marbled Burmese self doe
(a/a Bu/- c(h)/c)



Brown Marbled Burmese self doe
(a/a Bu/- c(h)/c)

BISCUIT (AKA PALE BURMESE)

When the Burmese gene works on a pink eyed white (c/c) background it causes the white rat to appear brown. A black based pink eyed white rat will be a brown biscuit colour ($a/a\ c/c\ Bu/-\ be/be$) and an agouti based pink eyed white rat ($A/-\ c/c\ Bu/-\ be/be$) will be a wheaten biscuit colour. Rats resulting from the Burmese gene working on a pink eyed white background do not have points as one needs the Himalayan (c^h) or the Sable Siamese allele (c^s) to create points.

Brown biscuit rats are a medium brown colour throughout with black eyes.



Brown biscuit berkshire buck
($a/a\ Bu/-\ c/c$)



Brown biscuit self doe
($a/a\ Bu/-\ c/c$)



Brown biscuit berkshire kitten
($a/a\ Bu/-\ c/c$)

Wheaten biscuit rats look like washed out cinnamons with black eyes.



Wheaten biscuit self buck
($A/-\ Bu/-\ c/c$)



Dumbo wheaten biscuit self buck
($A/-\ Bu/-\ c/c$)

BURMESE

All kinds of Siamese rats have a Burmese version giving many possibilities to create a Burmese rat. The intensity of the Siamese/Himalayan phenotype will affect the intensity of the Burmese phenotype. Thus a "Himalayan" Burmese rat ($a/a\ c^h/c\ Bu/-\ be/be$) will have paler points and less (or no) shading when compared to a "Sable Siamese" Burmese rat ($a/a\ c^s/c^s\ Bu/-\ be/be$).

The genotypes of Burmese rats	
Black based = Brown burmese	Agouti based = Wheaten burmese
$a/a\ c^h/c\ Bu/-\ be/be$	$A/-\ c^h/c\ Bu/-\ be/be$
$a/a\ c^h/c^h\ Bu/-\ be/be$	$A/-\ c^h/c^h\ Bu/-\ be/be$
$a/a\ c^s/c\ Bu/-\ be/be$	$A/-\ c^s/c\ Bu/-\ be/be$
$a/a\ c^s/c^s\ Bu/-\ be/be$	$A/-\ c^s/c^s\ Bu/-\ be/be$
$a/a\ c^h/c^s\ Bu/-\ be/be$	$A/-\ c^h/c^s\ Bu/-\ be/be$

Because the Burmese gene causes the colour to significantly darken, one cannot easily distinguish the different Siamese genotypes behind the Burmese background. If one has Siamese together with Burmese in the same line one can figure out the genetics of your Burmese rats, but if you do not know the ancestry of your Burmese rats, you will have to test mate the Burmeses with preferably pink eyed whites to figure out which Siamese gene causes the points on your Burmese. All the effects of the Himalayan and Sable Siamese alleles like darker colour in cool temperatures and typical faults of siamese and Himalayan rats will also affect Burmese rats.

Burmese (aka: Brown Burmese) - Body colour are a rich mid brown. Belly colour same as top. Points (which include nose, ears, front legs, hind legs and tail) are a dark brown colour, strongly contrasting with body colour. Eyes are black.



Dumbo brown Burmese self doe
(a/a Bu/- c(s)/c)



Dumbo brown Burmese irish doe
(a/a Bu/- c(s)/c(s))



Dumbo brown Burmese self kitten
(a/a Bu/- c(s)/c)

Wheaten Burmese - Body colour are a mid-sandy brown. Belly colour is a pale silvery grey. Points (which include nose, ears, front legs, hind legs and tail) are a dark sandy brown colour, strongly contrasting with body colour. Eyes are black.



Dumbo Wheaten Burmese self buck
(A/- Bu/- c(s)/c(s))



Dumbo Wheaten Burmese self doe
(A/- Bu/- c(s)/c(s))



Dumbo Wheaten Burmese self kitten
(A/- Bu/- c(s)/c(s))

Breeding good Burmese rats one has to select the brownest Burmese kittens. Avoid breeding with rats which show patchy or rusty colour in their fur. Good Burmese rats usually produce poor Siamese so if seriously breeding for show quality it is best to keep your show Burmese and show Siamese lines separate. Also try to select breeding stock from Burmese rats with the darkest points.

SABLE BURMESE

The darkest Burmese rats are known as Sable Burmese. Actually the term Sable Burmese has nothing to do with the Sable Siamese allele. It is a term coined separately overseas to describe these dark Burmeses. Sable Burmeses are plainly selectively bred from Burmese rats to give very dark colour. Siamese based Burmeses (a/a cⁿ/cⁿ Bu/- be/be) can be selectively bred to create Sable Burmeses, and so can Sable Siamese based Burmeses (a/a c^s/c^s Bu/- be/be). Obviously it is easier to get Sable Burmese from Sable Siamese based Burmese as Sable Siamese based Burmese rats are naturally darker than Siamese based Burmese rats.

Sable Burmese - Body colour is a dark otter brown, gradually and evenly shaded over saddle and hindquarters towards the belly, being the darkest at the tail base. Belly colour also dark otter brown. Points (which include nose, ears, front legs, hind legs and tail) are a black-brown colour. Eyes are black.



Dumbo Sable Burmese self buck
(a/a Bu/- c(s)/c(s))



Dumbo Sable Burmese self doe
(a/a Bu/- c(s)/c(s))



Sable Burmese irish kitten
(a/a Bu/- c(s)/c(s))

THE BLACK EYED GENE (Be gene) AND THE RESULTING COLOURS

In 2010 an article was published giving answers to the mystery behind the black eyed gene. Elisabeth Brooks from Spoiled Ratten Rattery in the USA sent some rats to Japan for genetic analysis. One of those rats was a black eyed Siamese. The black eyed gene is a dominant gene located on the same chromosome as the C-locus but is not part of the C-locus. It is a separate gene affecting the C-locus. Kuramoto, *et al.*, 2010 states that “the Be mutation is a single autosomal mutation and manifests dominantly only in the presence of the albino mutation in the homozygous state”. This means that one needs two copies of the Be mutation to get a black eyed rat* (Kuramoto, *et al.*, 2010).

The black eyed gene causes most notably the eye colour of C-locus varieties to be black. It also results in darker points and less intense shading on Himalayan (c^h) and Sable Siamese (c^s) based rats. According to Kuramoto, *et al.*, 2010 another feature of the black eyed gene is the slight yellowing of coat colour. This is most notable on agouti based rats, but very faint on black based rats. It is still unclear how the intensity of the yellowing effect is controlled genetically, but I suspect that polygenes result in more or less yellowing. One can selectively breed yellowish rats to become quite intense in colour. One can only notice the yellowing effect after the 6 week old mould in young rats. The yellowing effect intensifies slightly with each mould until adulthood.

*Even though the scientific article states that the black eyed gene manifests only in a homozygous state, I found that crossing black eyed rats with albino rats (which definitely do not carry the Be gene) still gives 50% black eyed kittens in the litter.

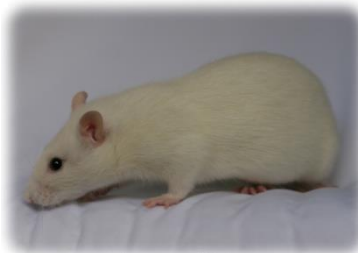
IVORY, BLACK EYED CREAM AND BISCUIT CREAM

When the black eyed gene works on a pink eyed white background you get the colour ivory ($a/a c/c Be/Be$) on black based pink eyed whites and on an agouti based pink eyed white you get black eyed cream ($A/- c/c Be/Be$). When you add Burmese to the equation you get biscuit cream ($a/a c/c Be/Be Bu/-$ or $A/- c/c Be/Be Bu/-$). Agouti based biscuit creams being of better shade since the yellow effect comes through stronger on an agouti based background. Black based biscuit creams can look phenotypically like normal biscuit in colour.

Ivory - Colour is a very pale creamy white. Belly colour matches top. Eye colour is black.



Dumbo ivory self buck
($a/a Be/Be c/c$)



Ivory self doe
($a/a Be/Be c/c$)



Ivory self kitten
($a/a Be/Be c/c$)

Cream - Colour is a rich warm cream. Ears have dark hairs. Belly colour is off white. Eye colour is black.



Black eyed cream self buck
($A/- Be/Be c/c$)



Black eyed cream hooded doe
($A/- Be/Be c/c$)

Biscuit cream - A yellow brown colour. Belly colour is a lighter than the top. Eye colour is black.



Biscuit cream hooded buck
(A/- Be/Be Bu/- c/c)

BLACK EYED HIMALAYANS AND SIAMESES

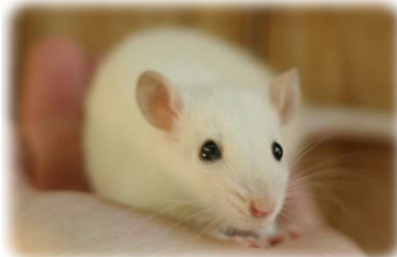
The black eyed gene affects all types of Siamese rats. The eyes are black and the points are darker. Shading is reduced on the black eyed versions. Agouti based black eyed Himalayan and Siamese rats have slightly yellower body colour and in some individuals it is so intense that the body colour becomes "golden" giving golden Himalayan and golden Siamese rats. Golden rats can be selectively bred to produce better, more intense golden Himalayan or Siamese rats. Black based black eyed rats also have this yellowing effect of the coat colour but it is less intense and less noticeable than with agouti based black eyed rats.

BLACK BASED COLOURS:

BLACK EYED SEAL POINT HIMALAYAN (a/a c^h/c Be/Be)



Dumbo Black eyed Seal point
Himalayan self doe
(a/a Be/Be c(h)/c)



Black eyed Seal point Himalayan
self kitten
(a/a Be/Be c(h)/c)

BLACK EYED SEAL POINT SIAMESE (a/a c^h/c^h Be/Be)



Dumbo Black eyed seal point
Siamese self buck
(a/a Be/Be c(h)/c(h))



Dumbo Black eyed seal point
Siamese berkshire doe
(a/a Be/Be c(h)/c(h))



Dumbo Black eyed seal point
Siamese irish kitten
(a/a Be/Be c(h)/c(h))

BLACK EYED SEAL POINT SABLE HIMALAYAN (a/a c^s/c Be/Be)



Black eyed Seal point Sable
Himalayan self buck
(a/a Be/Be c(s)/c)



Black eyed Seal point Sable
Himalayan berkshire kitten
(a/a Be/Be c(s)/c)

BLACK EYED SEAL POINT SABLE SIAMESE (a/a c^s/c^sBe/Be)



Black eyed Seal point Sable
Siamese self doe
(a/a Be/Be c(s)/c(s))

BLACK EYED SEAL POINT PASSE-PARTOUT SIAMESE (a/a c^h/c^sBe/Be)

AGOUTI BASED COLOURS:

BLACK EYED AGOUTI POINT HIMALAYAN (A/-c^h/c Be/Be)



Dumbo Black eyed Agouti point
Himalayan self doe
(A/- Be/Be c(h)/c)

BLACK EYED AGOUTI POINT SIAMESE AND GOLDEN HIMALAYAN (A/-c^h/c^hBe/Be)



Dumbo Black eyed Agouti point
Siamese self buck (less intense yellowing of
coat)
(A/- Be/Be c(h)/c(h))



Dumbo "Golden Himalayan" self
buck (more intense yellowing of coat, the Be gene causes
loss of shading thus we call him "Himalayan" and not "Siamese"
even though he is genetically a Siamese)
(A/- Be/Be c(h)/c(h))

BLACK EYED AGOUTI POINT SABLE HIMALAYAN (A/-c^s/c Be/Be)



Black eyed Agouti point Sable
Himalayan self doe
(A/- Be/Be c(s)/c)



Dumbo Black eyed Agouti point
Sable Himalayan self kitten
(A/- Be/Be c(s)/c)

BLACK EYED AGOUTI POINT SABLE SIAMESE AND GOLDEN SIAMESE (A/-c^s/c^sBe/Be)



Black eyed Agouti point Sable Siamese self buck
(less intense yellowing of coat)
(A/-Be/Be c(s)/c(s))



Black eyed Agouti point Sable Siamese self kitten
(A/-Be/Be c(s)/c(s))



Golden Sable Siamese self doe
(more intense yellowing of coat)
(A/-Be/Be c(s)/c(s))

BLACK EYED AGOUTI POINT PASSE-PARTOUT SIAMESE (A/-c^h/c^sBe/Be)



Dumbo Black eyed Agouti point Passe partout Siamese self buck
(A/-Be/Be c(h)/c(s))



Dumbo Black eyed Agouti point Passe partout Siamese self kitten
(A/-Be/Be c(h)/c(s))

BLACK EYED + BURMESE

The effects of the black eyed gene is not really noticed when the rat is Burmese. Sometimes one sees golden wheaten Burmese rats where the yellowing effect of the black eyed gene comes through on the Burmese background. This is similar to biscuit creams except that the rat has points.

The genotypes of Burmese rats	
Black based = Brown Burmese	Agouti based = Golden burmese
a/a c ^h /c Bu/- Be/Be Bu/-	A/-c ^h /c Bu/- Be/Be Bu/-
a/a c ^h /c ^h Bu/- Be/Be Bu/-	A/-c ^h /c ^h Bu/- Be/Be Bu/-
a/a c ^s /c Bu/- Be/Be Bu/-	A/-c ^s /c Bu/- Be/Be Bu/-
a/a c ^s /c ^s Bu/- Be/Be Bu/-	A/-c ^s /c ^s Bu/- Be/Be Bu/-
a/a c ^h /c ^s Bu/- Be/Be Bu/-	A/-c ^h /c ^s Bu/- Be/Be Bu/-



Golden Burmese irish buck
(A/-Be/Be Bu/- c(s)/c(s))



Golden Burmese berkshire doe
(A/-Be/Be Bu/- c(s)/c(s))

BLACK EYED + PINK EYED DILUTION

I had the opportunity to test cross the black eyed gene with pink eyed dilution in order to discover if the black eyed gene can express with pink eyed dilution. I crossed an amber female with albino siblings (thus I knew she carried "c") with one of my black eyed cream stud bucks. The black eyed cream buck carried pink eyed dilution and seemed to be homozygous for the black eyed gene as all his previous litter gave 100% black eyed kittens. The amber mother (A/A C/c be/be p/p) with the black eyed cream buck (A/A c/c Be/Be P/p) gave four amber, three pink eyed white and three agouti

kittens. None were black eyed, thus it seems that the black eyed gene either does not express on pink eyed dilution or that one indeed needs two copies of the black eyed gene to express as stated in the Kuramoto, et al., 2010 article.



The black eyed cream father (left) and the amber mother (right)



The amber x black eyed cream litter

Genetics

Most genes have two forms, also referred to as alleles, the wildtype form and a mutant form. For instance the A-locus has agouti (A) as the wildtype form and non-agouti or black (a) as the mutant form. A is dominant over a, and a is recessive to A.

The C-locus on the other hand has four alleles, wildtype (C) and three mutant alleles, namely: pink eyed white (c); Himalayan (c^h) and Sable Siamese (c^s). The C-locus therefore mutated three times. Wildtype (C) is dominant over all 3 mutant alleles, but the three mutant alleles express intermediate inheritance towards each other, meaning neither of them is dominant nor recessive over each other. This means when they are combined they show characteristics of both alleles. For instance c in its homozygous form is a pink eyed white rat (c/c). With the Himalayan allele (c^h), is the homozygous form a siamese rat (c^h/c^h), but when these two alleles are combined, a Himalayan rat (c^h/c) is formed which show characteristics of both alleles.

The pink eyed white allele (c) is also epistatic towards other mutations. A pink eyed white rat (c/c) can be any colour or marking but one cannot see the colours or markings on a pink eyed white rat, since the effects of the pink eyed white mutation “hides” the other colours. A pink eyed white rat has no pigment in its fur, meaning colours and markings which require pigment cannot express themselves.

Takashi Kuromoto proved that the black eyed gene (Be) is a separate gene also located on chromosome 1 (Kuramoto, 2010). It is very likely that the Burmese gene (Bu) is also a separate gene located on chromosome 1 if one looks at how it behaves in relation to the C-locus and when compared to the Be gene’s behaviour. Unfortunately the Bu gene has not been scientifically studied yet.

A note on scientific nomenclature of the C-locus:

In science circles the C-locus is actually known as the tyrosinase gene. A pink eyed white (c/c) is written as tyr^c/tyr^c in scientific documents (Janvier labs, 2015). Siamese would be written as tyr^{sia}/tyr^{sia} since Takashi Kuramoto gave the mutation the symbol “sia” when he published his research (Kuramoto, *et al.*, 2010). However, in the rat fancy we still stick to the old C symbols to avoid too much confusion.

Temperament issues

Both the mutations resulting from the Himalayan allele (c^h) and from the Sable Siamese allele (c^s) can be skittish rats. In the USA some Siamese rats (all are of the Himalayan allele) have temperament problems. This is a result of bad breeding practices (Royer, 1996). Luckily in South Africa we do not have many problems with the Himalayan allele (c^h) Siameses, but many people complain about the sable Siamese (c^s). Part of our problem with the Sable Siamese is that they are from feeder stock and not selectively bred for good temperament. Yet, there are very nice friendly Siamese rats out there of both the Himalayan (c^h) and the Sable Siamese (c^s) alleles. When working with any rats from the C-locus one have to take extra precaution to breed for good temperament since it seems that it is easy to go the wrong way with temperament with these rats.

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