

GOVERNING COUNCIL OF THE CAT FANCY

**GCCF POLICY ON THE USE OF OUTCROSSING IN CAT BREEDING
PROGRAMMES**

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A breed is defined as a group of animals related by descent from common ancestors that are visibly similar in most characters. Breeds generally refer to a distinct group of domesticated animals that are different from the wild type, are under the influence of man, and are incapable of maintaining their distinctive qualities in nature. Most cat breeds do fit these descriptions, however, a few cat breeds closely mimic their native populations of origin. Genetic tests are available for the cat, which define a majority of their colours, fur types, and morphological traits. Cats can be genetically defined to their breed and to their populations of origin from various regions of the world. Many genetic diseases can now be monitored and tests can prove parentage and percentage of wild felid genetic contributions in hybrid breeds. Therefore, undesired colors, traits, and diseases can be avoided, even when breeding with cats of unknown ancestry. Armed with these genetic tools, cat breeders and registries can now make more informed decisions regarding the propagation of their breeds with the wise selection of appropriate cats. While many cat breeds show high genetic diversity, implying healthy gene pools, other cat breeds clearly have gene pools that are insufficient for maintenance of a healthy genetic population. Because the DNA tests are available, easy to acquire, and relatively low cost, cat breeders and registries can easily consider outcrossing programmes that will not significantly sacrifice the breed standards. Most societies insist that humans have great responsibility to be humane and to treat animals with high regard and value. Animal welfare, which includes an animal's health, must be at the forefront of ethics for the cat fancy. The proper use of genetic tests and cooperation between the registries and breeders and amongst the breeders can support healthy futures for cats and their breed populations.

GCCF policy on the use of outcrossing in cat breeding programmes

Outcrossing is the introduction of new genetic material into a breeding line or a breed's gene pool. It involves the mating together of cats of different varieties, different breeds or of a pedigree cat to a 'foundation cat' of unrecorded ancestry as part of a planned and coordinated programme to improve the genetic diversity and genetic health of a breed. It can sometimes also be used to introduce new, desirable traits to a breed. It is one of the most important tools that can be used by breeders to maintain or improve their breed's genetic health and guard against the negative health consequences of inbreeding and closed gene pools. An outcross programme is a long term undertaking that can require a commitment to breed through several generations.

Why is Outcrossing necessary?

1) Combating inbreeding depression

Inbreeding is the mating together of related individuals. There are various degrees of inbreeding, the closest of which is first degree inbreeding, or the mating together of two siblings or a parent with its offspring. First degree inbreeding is now not considered acceptable and offspring of such matings cannot normally be registered on the GCCF active register because the kittens produced have very high inbreeding levels, with coefficients of at least 25% and an increased risk of genetic health issues. Line breeding is the mating together of less closely related individuals and almost all pedigree breeding involves some sort of line breeding as the creation of pedigree breeds relies on establishing foundation individuals and breeding like to like. Most pedigree animals have a certain level of background inbreeding but with a sufficiently large and diverse gene pool these levels can be kept low and remain sufficiently safe. When a gene pool is small because it has a low number of founders, or has been through a population bottleneck, then inbreeding levels can rise even from matings between individuals which are apparently not closely related.

Any breed, breeding line or individual can suffer from inbreeding depression when inbreeding coefficients are raised to high levels and a loss of heterozygosity results. Inbreeding depression can result in a general loss of vigour, even if the animals in question are not suffering from specific recessive genetic diseases. A small gene pool can result in inbreeding depression in a breed. A popular and numerous breed with a small gene pool has a low 'effective population size', regardless of the numerical size of the breed's population.

Inbreeding depression can compromise a cat's immune system and make it less able to resist disease. A group of genes called the Major Histocompatibility Complex (MHC) plays an important role in the immune system. Because the genes in the MHC are inherited as a large cluster it is particularly vulnerable to inbreeding depression and a loss of genetic diversity in the MHC can impact on the health of the cat and its ability to fight diseases.

Inbreeding depression can manifest in different ways depending on the particular make-up of the gene pool in question. Few cases of inbreeding depression will manifest all of the signs. Although these are problems which can occur in any random-bred cat, a combination of some of these signs could well indicate a problem with inbreeding depression. A breeder who is worried

about inbreeding levels in their lines should consider introducing cats from different lines or outcrossing to approved breeds.

Signs of inbreeding depression that have been demonstrated in other domesticated breeds include slow growth rate, small adult body size, small litter size, reduced fertility, increased kitten mortality, increased prevalence of allergies, reduced ability to fight infections, physical asymmetries - especially facial, an increase in congenital abnormalities, increased prevalence of cancers, increased incidence of genetic disease, and reduced life expectancy.

Levels of Coefficients of Inbreeding (COIs);		
Percentage	Level	Comments
0 to 10 %	Low	COIs which fall within this low banding are ideal
10 to 20 %	Fair	COIs which fall within this banding are reasonable and acceptable
20 to 25%	Close	COIs which fall within this banding represent close matings approaching the higher end of what breeders should normally consider
25 to 40%	High	Matings producing higher COIs than first degree matings should only ever be undertaken by experienced breeders for very specific reasons. If offspring are retained for breeding they should only be used for matings producing low COIs.
40%+	Not advised	The welfare and health of cats with such high levels of inbreeding is highly likely to be compromised and such matings should not be undertaken.

Inbreeding coefficients should ideally be calculated back to foundation (i.e. the original cats used to found the breed) in order to give the most accurate reading possible. Many breed clubs hold databases and many breed databases are publicly available on line at websites such as pawpeds.com so help is available for breeders wishing to calculate as far back as possible. Breeders who have no options for matings with inbreeding coefficients within safe levels have effectively bred themselves into a corner and should consider progressing by carrying out an outcross mating.

However, it should not be assumed that recorded pedigrees are 100% accurate. Genetic parentage testing has never been used to document the accuracy of pedigrees and any error in a pedigree could potentially cause a significant miscalculation in an inbreeding estimation.

Outcrossing is necessary to address high inbreeding levels and maintain genetic diversity within a breed's gene pool. With each outcross mating inbreeding levels fall and genetic diversity rises, providing benefits to the overall health of the gene pool.

Why is Outcrossing necessary?

2) Combating genetic erosion

Genetic erosion is the process by which all closed gene pools gradually shrink over time and genetic diversity declines. All individuals have a unique combination of genes and genetic

erosion happens when individuals are neutered or die before being able to breed and pass on their genes. In cats the vast majority of kittens are neutered and are not used for breeding so the process of genetic erosion occurs more rapidly than it would in an endangered wild species. All closed gene pools are subject to genetic erosion although the process can be slowed down with good management, such as not keeping males at stud for too many matings and careful cooperation between breeders. A breed which has kept a closed gene pool for too long will experience loss of diversity and be at risk of the health problems associated with high inbreeding coefficients. Any breed without an active outcross programme in place will experience a gradual decline in genetic diversity so outcrossing is vital for the long term health of all breeds. A steady trickle of new blood coming into a breed balances this gradual loss. Breeders can address this by maintaining outcross options and promoting their appropriate use.

Why is Outcrossing necessary?

3) Combating genetic drift

Genetic drift is the process by which the frequency of a particular gene increases or decreases within a gene pool over several generations. It takes place because not all individuals in each generation contribute their genes to the next generation to the same degree. Some individuals may not contribute to the next generation at all, others may only pass on their genes to a few offspring, while others may be prolific breeders. Genetic drift speeds up when a breed or species goes through a population bottleneck and the number of breeding animals declines. A popular stud can cause genetic drift by contributing his genes to a high proportion of offspring. This can result in a loss of genetic diversity and if one of the genes whose frequency is increased is a disease gene this can cause serious problems for a breed. Genetic drift can result in a disease gene spreading throughout a breed and it can happen to well established and diverse breeds, for example PKD in Persians and PK Deficiency in Abyssinians. The spread of a disease gene can even be further increased when it is a Trojan horse, bringing a benefit with an unsuspected disadvantage hidden within, for example in American Burmese carriers of a gene causing a head defect had shorter head type and were inadvertently selected by breeders for breeding.

The same applies to wild species of cat and conservation biologists have studied the impact of population bottlenecks and reduced genetic diversity in the Cheetah, which has been found to have low levels of genetic diversity. This has impacted on their genetic health and the species consequently has a high susceptibility to FIP (Feline Infectious Peritonitis).

Outcrossing helps to maintain genetic diversity which guards against genetic drift and its potential negative effects. Outcrossing is also a vital tool to remedy the effects of genetic drift where breeders want to address changes which have taken place within a gene pool, introduce new foundation stock or replenish a depleted gene pool.

Another reason to outcross: introducing new traits

The principal reason for outcrossing programmes in animal breeding is to maintain good genetic health and diversity and this would be the goal of the majority of outcross matings. However, one other advantage of outcrossing is the opportunity to introduce genes for new traits in a breed, such as new colours. Many new colours and patterns have been introduced to cat breeds through outcrossing.

The approach to outcrossing for new traits may be different as the main focus of such a breeding programme is to obtain and retain one gene. This is easy with a dominant gene where the trait is expressed if the gene is present, but less easy with a recessive gene. DNA testing allows breeders to keep track of carriers but not all colour and pattern genes have DNA tests available.

Although the individuals used as outcrosses will contribute some fresh blood into the gene pool the breeding programme for a new trait will not necessarily be designed to maximise on this and once the new gene has been established there will be no need to repeat the outcross. However, breeders should be wary of relying too heavily on one outcross line as this could give rise to increasing inbreeding, especially when working with a recessive trait. In this situation it is better to establish several unrelated outcross lines for the same new trait in order to produce greater diversity.

Examples of cat varieties which have been produced by outcrossing programmes to introduce genes for new traits:

- Cinnamon, chocolate and colourpoint British Shorthairs
- Red, cream and tortie Burmese
- Chocolate and lilac Abyssinians

Pedigree Outcrossing

The permitted outcross options for many pedigree cat breeds are cats of other pedigree breeds. These are normally breeds of similar type as this allows for desired breed type to be regained more easily. Outcrossing is common between breeds within breed groups or which have sister breeds, for example Siamese are used as an outcross for both Orientals and Balinese, and Burmese are used as an outcross for Asians. Breeds which are not part of a grouping often use cats of similar type, for example British are permitted as an outcross for RagaMuffins.

The advantages of using pedigree outcrosses are;

- All of the ancestors are known and the cats produced have a full pedigree.
- With known ancestors which have been bred for consistent type, the breeding outcomes are normally more predictable and breeders will have a clearer idea of how to progress and what to select for in order to meet the goals of their breeding programme.
- There is less scope for atavistic surprises (traits inherited from unknown ancestors)
- No delay in showing caused by unknown ancestors

- DNA testing can be enforced to screen out many of the disease genes known in the specific breeds which are used.

Use of Outcross Options

The outcross options permitted in a breed's registration policy must be carefully considered in order to ensure that genuine, practical and viable sources of appropriate fresh blood are in place. No breed should have a closed gene pool but BACs must also be mindful that breed groupings can also form closed gene pools. A breed whose only outcross option is to a related breed with a closed gene pool just becomes an extension of that closed gene pool and is subject to the same risks.

A breed which is a sister breed or closely related to another breed may successfully use that breed as its sole outcross option only if the source breed does not have a closed gene pool and has its own source of fresh blood. The Nebelung, for example, has the Russian Blue as its sole outcross option; however, these two breeds do not form a combined closed gene pool as Russian breeders are permitted to develop new blood lines from outcrosses to domestic shorthairs. As generations progress, this new blood can filter through the combined gene pool and ultimately benefit both breeds.

Breeders of breeds which do not bear a close relationship to another breed should be careful to avoid the imprinting of breed type from another breed as a result of overreliance on one particular outcross option. Such breeds should allow a wide range of suitable outcross options to be used in order to provide balance. Allowing a wide range of different outcross lines to be developed not only prevents a skewing of the breed's type to that of one outcross breed, but also provides a far better improvement to the breed's genetic diversity. For example, the GCCF Devon Rex registration policy allows seven different outcross options and this broad range allows for good balance, thus avoiding any undesirable heavy influence in type from one breed. In contrast, Devon Rex breeders in the USA went through a period where the American Shorthair was used heavily as an outcross option, without much use of other options to provide balance. This resulted in some loss of type that breeders had to work hard to correct.

So in order to obtain the best genetic diversity (and the good genetic health outcomes that result from this) as well as the best balance for avoiding loss of good breed type a good range of outcross options is recommended. BACs should not worry about which outcross options to use from the list of potential breeds, instead they should take a more inclusive approach and not rule out any viable, appropriate option, which may have something beneficial to offer their breed's gene pool.

Foundation Cat and Domestic Outcrossing

Some cat breeds use non-pedigree cats as outcrosses. These are often referred to as Domestic Longhairs or Domestic Shorthairs and they should be demonstrably healthy cats of no known or suspected pedigree ancestry. In some cases non-pedigree cats can be used only if they are of a particular colour or pattern and/or if they come from a specific geographical location relevant to the origins and history of the breed. Such cats are often referred to as ‘foundation cats’.

‘Foundation cats’ are particularly useful to landrace breeds – breeds developed from cats of a certain type indigenous to one place. These breeds are first developed from such ‘foundation cats’ and breeders can ‘return to source’ to find new ‘foundation cats’ at any time when new blood is needed. These new foundation lines form part of an outcross programme and sufficient generations need to be bred and kept under observation before progeny can come off the reference register and be shown in competition at cat shows.

Some GCCF breeds which permit the use of ‘foundation cats’

Breed	Note
Norwegian Forest Cat	Foundation cats allowed in the pedigrees of imports
Siberian	Foundation cats allowed in the pedigrees of imports. DNA screening required. Foundation cats must have been born in Russia
Turkish Van	Foundation cats of the correct pattern from the Lake Van area are permitted
Manx	Foundation Tailless Manx from the Isle of Man are permitted
Egyptian Mau	Foundation cats allowed in the pedigrees of imports
Khao Manee	Foundation Khao Manees of authenticated Thai origin permitted
Korat	Foundation Korats of authenticated Thai origin permitted
Singapura	Foundation shorthaired ticked tabby cats authenticated as originating from Singapore or its neighbouring countries are permitted

There are some other breeds where the use of ‘foundation cats’ could be considered appropriate.

Domestic cats are used as an outcross option by certain breeds where non-pedigree outcrosses are permitted but there is no specific requirement for cats to be sourced from a certain geographical location relevant to the breed’s origins.

Some GCCF Breeds which permit the use of domestic cats

Breed	Note
LaPerm	Long or short hair. No colour restriction.
Russian	Black or blue shorthair only.
Sphynx	Shorthair. No colour restriction.
Australian Mist	Shorthair, blue or brown spotted or classic tabby.

Advantages of using non-pedigree domestic or foundation outcrosses

- Non-pedigree cats have the greatest genetic diversity
- Hybrid vigour contributes to good health outcomes
- Vast size of the domestic gene pool gives a unlimited source of new blood to draw upon
- Authentic foundation lines can be sourced where there is a geographic link to the breed's origins
- General health checks can be used to screen for signs of good health

Breeders working with outcrosses from cats of unknown parentage also have specific challenges which they need to take into account. Without knowledge of the cat's pedigree background, breeders need to monitor outcross lines from such cats closely to check for unpredictable outcomes or unforeseen atavistic traits (i.e. traits possessed by unknown ancestors, which may or may not be desirable).

Breeders should also consider the choice of individual cats of unknown parentage for use in an outcross programme very carefully. Health should be checked by a vet to ensure that robust, healthy individuals are used. Type should be assessed carefully to ensure that the cat's type is as close as possible to the desired outcome. The cat's origins should also be considered; isolated farm or feral cat colonies can be very inbred and are not ideal.

Registration of cats from an outcross programme

Cats are registered on different registers with the GCCF, depending the stage of recognition of each variety and on their factors outlined in each breed's registration policy, such as the generational level within an outcross programme.

Register	Use
Full register	For 'purebred' cats with three or more generations of like to like breeding and no outcross breeds appearing for three or more generations.
Supplementary Register	For cats with approved outcross breeds appearing in their pedigrees (normally within three generations) but which are allowed to be shown.
Experimental Register	For breeds or varieties with preliminary recognition. Some breeds may use this register when undertaking an outcross programme to develop a new variety (e.g. new colour, pattern or hair length) if it is going to be judged in a new class.
Reference Register	In an outcross programme the reference register is used for cats with approved outcross breeds in their pedigrees (normally within three generations, but sometimes five) but which are not allowed to be shown. Cats with any unknown ancestors within three generations

	are always placed on the reference register.
Genetic Register	For cats which have not yet been proven by veterinary screening or DNA test to be free of medical conditions or undesirable genes (i.e. genes which can causes genetic diseases or colour/pattern/coat genes not permitted within a breed), or for cats known to carry undesirable genes but which are still permitted to be used in breeding.

Techniques and methods for outcross programmes

Careful forward planning is needed for any outcross programme, as the breeders involved should be prepared for a long term undertaking. There could be many cats to breed over several generations, with kittens and adults to find homes for. Breeders should have an idea of how they are going to progress each generation towards their goal.

Before starting an outcross programme the breeder should check the breeding and registration policies for their breed and follow guidance from their BAC. They should check any details they are unsure of with their BAC. Any experimental programme, such as one to introduce a new colour, or one involving a non-approved breed should be first submitted as a proposal to the BAC.

Where possible, breeders should plan and work collaboratively developing outcross lines together. The more outcrosses used as part of a breeding programme the greater the input of new blood and the impact on the breed's genetic diversity.

Where one outcross is undertaken, with each generation being bred back into the existing gene pool the percentage of fresh blood diminished by half in each generation.

Generation	Pedigree level of outcross cat	Percentage of fresh blood
F1	Parent	50%
F2	Grandparent	25%
F3	Great Grandparent	12.5%
F4	Great Great Grandparent	6.25%
F5	Great Great Great Grandparent	3.12%

In order to avoid the gradual loss of new blood from the gene pool there needs to be some doubling up of outcross lines. A cat with more than one different outcross line in its pedigree will have better genetic diversity, so combining different outcross lines can be a useful technique.

The use of line breeding of cats from one outcross line can also ensure a greater input of the new blood from that line is retained.

As each generation is bred in an outcross programme the breeder should assess the kittens in order to select the ones which will be used to breed the next generation. These should be the ones which have the best desired breed type, but this should not be the only consideration. Robust and healthy kittens with good temperament should be selected. In some programmes DNA screening for the presence or absence of certain genes will also be a consideration. In programmes where variants are produced (especially in the first generation) breeders should assess those characteristics which are present.

Breeders should not expect excellent type in the first generation, but should see successive improvements with each generation. First or second generation kittens should not be looked down upon for not being type because it is a normal part of the outcrossing process to select to regain and improve type as the programme progresses. Sometimes good type is regained very quickly and many cats on the supplementary register with outcross breeds close behind them have gained titles.

BACs should provide guidance on the use of approved outcrosses in their breeding policies. Breeders wishing to have an independent assessment of kittens from an outcross programme which cannot be shown should consider placing them on exhibition at a show and obtaining feedback from a judge, in order to help them with their breeding decisions.

Selection of cats to use as outcrosses

When selecting a cat to use as an outcross there are many factors for the breeder to take into consideration. The cat used should be in excellent health, with a good temperament. If the cat has been used before for breeding it should have had good results. The cat's type should not necessarily be good for its breed and sometimes a cat of poor type for its own breed is the best choice for an outcross for another breed, for example, the British Shorthair is one of the approved outcross breeds for the Cornish Rex; a British Shorthair with ears which were too large and a face which was too long to be considered a good example of its breed would make a more suitable cat for outcrossing with a Cornish Rex than a show quality British Shorthair.

Use of DNA testing

The blood group of the outcross cat may also need to be taken into consideration, especially in breeds which have both blood types and need to avoid incompatible matings, or in breeds which have only A blood type and do not wish to introduce B. The preferred method of blood typing cats is by DNA test as this is less invasive and provides more informative results.

DNA testing can also be used to verify which genes for coat texture, length, colour and pattern are carried in order to retain desirable genes and screen out undesirable ones.

Appropriate use of DNA testing should also be made to screen for any breed-related genetic diseases to avoid the introduction of these genes to other breeds, for example British Shorthairs and Persians must be tested clear of PKD (polycystic kidney disease) before they can be used as outcrosses for the Selkirk Rex. General veterinary health checks should also take place for any domestic or foundation cats used.

Challenges of outcrossing

Undertaking an outcross programme is not without its challenges and potential pitfalls. As well as selecting the right kittens to regain good breed type, the breeder must be responsible for closely monitoring the outcross lines to ensure that good results are achieved and health is maintained. Cats from outcross lines registered on the reference or supplementary registers need scrutiny from breeders to ensure that they are suitable for transfer onto the full register once the required generational level is produced. If an outcross does not achieve good results or if an undesirable gene is accidentally introduced then the line can be stopped or remedial action can be taken.

Conclusion

Outcrossing is a vital way to maintain and improve the genetic diversity and genetic health of a breed and it guards against the deleterious consequences of a closed gene pool. The GCCF Genetics Committee requires that all breeds should have a viable and appropriate list of approved outcross breeds and that BACs should promote the responsible use of outcrossing as a way of maintaining and improving the genetic health of all cat breeds. Breed groupings containing breeds which outcross to each other, but which as a whole constitute a closed gene pool cannot be considered to have viable outcross options. If any breeder of a breed which maintains a closed gene pool wishes to carry out an outcross mating they can make an appeal to the Genetics Committee and Board of Directors for approval of an experimental breeding programme.

Case studies

The following examples illustrate the results that can be achieved from different kinds of outcross programmes. These different kinds of outcross programme vary according to what is suitable for the individual breed. Outcrosses can be made with cats of breeds with different type and these require work over the following generations to regain good type. Breeders undertaking this sort of outcross need a good eye for breed type and kitten potential. Other breeds have breeds of very similar type, which may be considered 'sister breeds'; with outcrosses to such breeds good type can be achieved in the first generation. In breeds which use foundation cats for outcrossing the parentage of the individual cat may not be known but they will be of the correct appearance and from the correct geographical area for the breed. Cats will be chosen which have type which is close to desired type in the pedigree breed as possible, but some work will need to be done to build up a pedigree record and improve type. Another group of breeds produce first generation variants which lack a feature critical to the breed but carry a gene for that feature. The variants carrying the desirable gene can then produce kittens displaying the feature when mated to a cat of the breed.



Case Study 1: Outcross from sister breed

Female Asian Chocolate Ticked Tabby Olympian Bronze Imperial Grand Champion Kagura Galadriel, whose parents are Gr Ch Kagura Xaracen (Lilac Burmese) and Imp Gr Ch Beannoch Fionnuala (Asian Choc Ticked Tabby with BCR).

For those breeds which have a sister breed that they can use to outcross to, the type is essentially the same between the two breeds so excellent type can be produced in

the first generation and many such cats are very good examples of their breed and can achieve show success.

Case Study 2: Outcross from a breed of different type - Birman

When an outcross mating is undertaken with a breed of different type the resulting first generation kittens normally have intermediate type and are unlikely to be show quality. In some breeds they are not permitted to be shown for between one and three generations.

Parents



Champion Aylpurrtona Reddy Teddy, red point Birman, and Johnnycake Heidi, seal tortie point Persian. The Persian female was chosen as a suitable outcross because she is from a breed approved by the Birman BAC for outcrossing, she is not an extreme typed Persian, she was not closely related to other Persians used in Birman outcrossing and she had been proven to be free of PKD by DNA testing.

First Generation



Purrindoors Powderpuff, a red point first generation Birman Variant shows intermediate type and lacks Birman gloving, although she carries the recessive gene for it.

Second Generation



Second generation cats have regained basic Birman type and do not show the same influence from the Persian on their head length as the first generation. Birman gloving can be regained in this generation.

Third Generation



Good type can be achieved by the third generation and breeders can focus on finer details.

Fourth Generation



Fourth generation cats should have regained good quality type and can be shown and compete well with other cats. They should have good genetic diversity, which contributes to the diversity of the breed's overall gene pool and to the health of the individual cats.

Case Study 3: Outcross producing Variants – Devon Rex x Asian Shorthair

When an outcross mating is carried out in a breed where the breed defining feature is determined by a recessive gene all first generation kittens (F1) are variants. In the second generation the breed feature can be produced again. There can be some variation in quality with excellent cats at the second generation in some lines and some work to improve features such as type and coat in other lines.

The initial outcross mating was carried out by Kate Ekanger, Cloudborn Devon Rex, between Ch Bountiful Bun Biter (Devon Rex) and Karakoram Mistletoe (Asian Shorthair). It was developed into two lines at the F2 level: Cloudborn (then DaddyO) – Line 1; and Cherek – Line 2.

For a fuller set of photos from this outcross line please see the following link;

<https://www.flickr.com/photos/cherekbear/collections/72157646951312241/>

Parents and First Generation



Outcross parent (Asian Ticked Tabby), Devon Rex parent and first generation variant offspring, ticked tabby Devon Rex Variant Cloudborn Hyoscine. The F1 variant has a normal straight coat like her Asian parent, but carries the recessive Devon Rex gene.

Second Generation



Two F2 Devon Rex females (Ch Cloudborn Eftwootsie (L) and Cloudborn Eftwooth-fairy (R)) both kittens of Cloudborn Hyoscine above but with different fathers. There is more variability in the type of kittens in the second generation, with the cat on the left gaining a title, while the cat on the right has a rather plush and poorly rexed coat.

Third Generation



Cloudborn Amelie Fthreeps, daughter of Cloudborn Eftwootsie above, as a kitten and as an adult. Good quality Devon Rex with good type and rexing



Cherek Smart Cookie, daughter of Cloudborn Eftwooth-fairy above, as a kitten and as an adult. Improved coat and type, although still not well rexed.

Fourth Generation



DaddyO Dirty Gertie (L), daughter of Cloudborn Amelie Fthreeps above, showing excellent Devon Rex type and coat, and litter of F4 kittens (R) from Cherek Smart Cookie above, showing good promise.

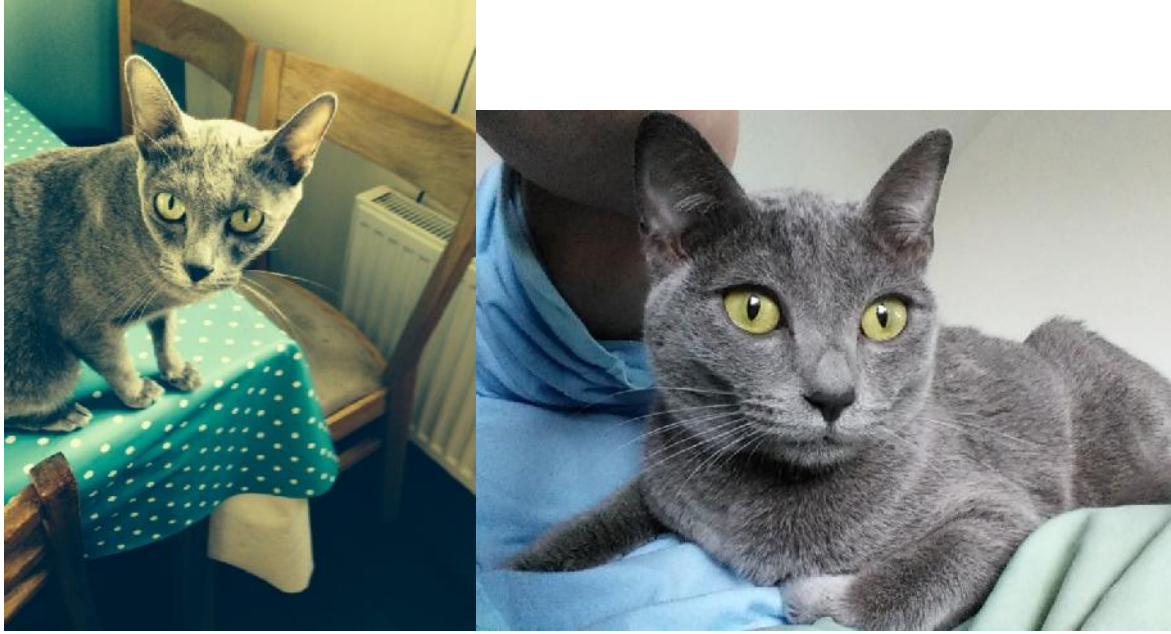
Case study 4: Outcross Using Foundation Cats - Korat

An outcross mating to a foundation cat requires the breeder to source a suitable cat with good type bearing as many similarities as possible to desired breed type, with the correct appearance and geographical origin. These foundation cats may not have known parentage so there may be a

higher degree of unpredictability in the breeding outcomes of the first and second generations and breeders undertaking an outcross programme of this nature need to focus on selecting the best kittens in order to set good type and build up a pedigree record with successive generations towards obtaining progeny which can be shown. Foundation cats and domestic cat outcrosses provide the greatest boost to a breed's genetic diversity.



Khun Preecha's Saothai, a foundation Korat born in Thailand and imported to the UK to provide a new blood line for the breed's gene pool. She is pictured here with her litter of kittens sired by a GCCF registered Korat. The kittens were registered on the reference register as first generation Korats. Saothai is not very different from a pedigree Korat, but she is a little longer in the nose and finer in the muzzle so slightly more Oriental in type rather than the heart shape head type expected in pedigree Korats. She underwent DNA testing and was shown not to carry the chocolate or colourpoint genes but does carry the Burmese gene, which is common in the random breeding feline population of South East Asia. It will be easy to screen this out of her future progeny with the tool of DNA testing.



As can be expected in the first generation, there was some variation in her kittens. Pictured above are two females from the litter shown at seven months old. The cat on the left was had less good type with a longer and more narrow head and white hairs in her coat; she was neutered and homed as a characterful and well-loved pet. The cat on the right showed better type, with more balance, a much shorter nose, a face developing the desired heart shape, good coat quality and eye colour; she has been kept for breeding to further the new blood line.

Overview of Outcross Allowances in Cat Breeds Recognised By The GCCF

Breeds shown in the Potential Outcrosses column are suggestions of further options which could be considered by BACs.

BREED	PERMITTED OUTCROSSES	POTENTIAL OUTCROSSES	NOTES
Persian Section			
Persian	Exotic LH (limited)	Exotic LH (Neg. PKD/HCM) British SH and British LH (Neg. PKD/HCM)	Closed gene pool for Persian/Exotic grouping, but gene pool is currently large with greater than average diversity.*
Exotic	Persian		
Semi Longhair Section			
Birman	Persian (limited)	Thai Blue Point Colourpoint Ragdoll (No White Spotting) (Neg. HCM) Colourpointed Snowshoe, (inc. LH Variant) (No White Spotting)	While some outcrossing is allowed, more should be done to encourage it as the Birman gene pool is currently one of the smallest.*
Maine Coon	Foundation Maine Coons		Above average genetic diversity* and a defined source of new blood. Wording in the registration policy could be clarified.
Nebelung	Russian Blue Foundation Nebelung (within the pedigree of imports only)	Russian Blue with Russian Black/White in pedigree Russian Blue with Domestic SH outcross in pedigree Foundation Nebelung	Nebelungs in the UK are expected to have good genetic diversity

		Blue Domestic Longhair	
Norwegian Forest Cat	Foundation Norwegian Forest Cats		Above average genetic diversity* and a defined source of new blood.
Ragdoll	Pending	Colourpoint Persian (Neg. PKD/HCM) Snowshoe (sg negative) Domestic LH	Review of outcross option pending
Siberian	Foundation Siberians		Above average genetic diversity* and a defined source of new blood.
Somali	Abyssinian		The Somali relies exclusively on the Abyssinian for fresh blood. The Abyssinian gene pool has low genetic diversity.
Turkish Van /Turkish Vankedis	Foundation Turkish Van/Turkish Vankedis		The Turkish Van has average genetic diversity* and a source of diverse new blood.
Turkish Angora	Foundation Turkish Angora		The Turkish Angora has above average genetic diversity and a source of diverse new blood.
RagaMuffin	British Shorthair British Longhair	Persian (Neg. PKD/HCM) Ragdoll (Neg. PKD/HCM)	RagaMuffins in the UK are expected to have good genetic diversity and their outcross option also offers access to a source of genes with good diversity.
British section			
British Shorthair		Domestic SH	Closed gene pool, but currently has above average genetic diversity*. The registration policy states that the BAC

			can grant progression to outcrossed cats on the reference register if a proposed breeding programme is submitted and agreed. More clarity on this should be provided, including guidance in the breeding policy on how this allowance could be used for DSH outcrosses to contribute to genetic diversity and pedigree outcrosses where new colours or patterns are to be introduced.
Manx	British SH Foundation Manx (preferred option)	Domestic SH (if difficulties arise in future in obtaining Foundation Manx)	Small numbers in the GCCF but with access to foundation cats, pedigree Manx imports and outcross to British SH providing scope to retain good diversity
Selkirk Rex	British SH British SH Variant (LH) Persian Exotic SH Exotic LH (American SH)		Selkirk Rex in the UK are expected to have good genetic diversity with a good range of outcross breeds which themselves have above average diversity.
Foreign section			
Abyssinian	Pending	Domestic SH Burmese (Test F2s for cb) Colourpointed Snowshoe (No white spotting) (Test F2s for cs)	Closed gene pool with low genetic diversity. Review of outcross options and registration policy required.

		Korat Foundation Abyssinian (i.e. Ticked tabby cat from Asian or Eastern African countries)	
Asian Group	Burmese Korat Thai Lilac Abyssinian Tonkinese BCR Egyptian Mau Ocicat & Ocicat Classic Australian Mist Somali LH & SH		Diverse range of outcrosses reduces reliance on small Burmese gene pool.
Bengal	Pending	Abyssinian (Neg. PRA/PK Def.) Burmese Egyptian Mau Ocicat (Neg. PRA/PK Def.) Tonkinese Domestic SH (American SH)	Closed gene pool. Review of outcross options and registration policy required
Cornish Rex	Abyssinian	Snowshoe	Diverse range of outcrosses

	<p>Asian SH</p> <p>British SH</p> <p>Burmese</p> <p>Ocicat</p> <p>Oriental</p> <p>Russian</p> <p>Siamese</p> <p>Tonkinese</p> <p>(American SH)</p> <p>(European SH)</p>	Domestic SH	
Devon Rex	<p>Abyssinian</p> <p>Asian SH</p> <p>British SH</p> <p>Burmese</p> <p>Korat</p> <p>(American SH)</p> <p>(European SH)</p>	Domestic SH	Diverse range of outcrosses
Egyptian Mau	<p>Foundation Egyptian Maus (Spotted tabby cats from Egypt and surrounding Mediterranean countries)</p>		The Egyptian Mau has slightly above average genetic diversity* and a source of diverse new blood. Foundation cats must be registered in another registry before

			they can be registered with GCCF.
Khao Manee	Foundation Khao Manee	Korat	Although only small numbers are present in the UK, diverse foundation lines have been used and a good source of fresh blood is in place.
Korat/Thai	Foundation Korats	Khao Manee Variant	Average genetic diversity* with a good source of fresh blood in place
LaPerm	Abyssinian Asian Group Burmese Ocicat Somali Tonkinese Domestic SH/LH	Egyptian Mau Snowshoe	Diverse range of outcrosses
Ocicat	Abyssinian (ex. Red series)		Relies exclusively on a breed with a closed gene pool and limited genetic diversity.
Russian	Domestic SH		Lower than average genetic diversity demonstrated in research using American-bred cats*, however, new research is being undertaken to assess diversity in UK cats. Diversity should improve now that outcrossing option is in place.
Singapura	Foundation Singapura (Imported)		Very low genetic diversity* should improve now that outcrossing options are

	ticked tabby cats from S E Asia) Abyssinian Burmese Korat Domestic SH		in place.
Snowshoe	Siamese British SH Ragdoll	Domestic SH European SH Ocicat (Pointed Variant) Colourpointed Tonkinese	Snowshoes in the UK are expected to have good genetic diversity. They have good sources of fresh blood in place.
Sphynx	Domestic SH Russian Blue (American SH) (European SH)	Abyssinian (Neg. PRA/PK Def.) Ocicat (Neg. PRA/PK Def.) Snowshoe Tonkinese	Above average genetic diversity* with good sources of fresh blood in place.
Tonkinese	Burmese x Siamese F1 Tonkinese	Imported South East Asian cats with correct coat patterns (CPP, TCR, BCR)	Relies on two breeds with closed gene pools and below average levels of genetic diversity.
Burmese section			
Burmese	Pending	Asian Variant Foundation Burmese (Imported cats from S E Asia) Korat	Closed gene pool with very low genetic diversity. Review of outcross options and registration policy required.

		Tonkinese (cb/cb)	
Oriental section			
Oriental Shorthair	Siamese Oriental LH Oriental Bicolour Balinese	Foundation Oriental SH (i.e. imported cats from SE Asia)	Siamese/Oriental gene pool is a closed gene pool with lower than average genetic diversity. The other breeds within the group rely on the diversity of the Siamese gene pool. Options for incorporating new foundation lines should be considered.
Foreign White	Siamese		As above
Oriental Longhair	Balinese Oriental SH Siamese Oriental Bicolour		As above
Oriental Bicolour	Balinese Oriental SH Oriental Bicolour Siamese	Foundation oriental Bicolour (i.e. imported cats from SE Asia)	As above
Siamese section			
Siamese	Foreign White Oriental SH	Foundation Siamese (i.e. imported cats from SE Asia) Shorthaired Pointed Oriental Bicolour Variant (No white spotting. DNA tested as	As above

		not carrying LH)	
Balinese	Siamese	Oriental LH Variant (Pointed) Oriental Bicolour Variant (LH Pointed) Siamese with Oriental SH in pedigree	As above

*Data on genetic diversity in breeds from 'The Ascent of Cat Breeds' by Lipinski et al

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