PARROT GENETICS IN COLOR MUTATIONS

FOR NOVICE PET BIRD BREEDERS

A handy reference of practical applications for cage-bird breeders who want to produce certain colors in their stock or guarantee the sex of the offspring.

By

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The subject of genetics can be either an all-consuming lifetime study for a professor in research, or for us more average people, an effective tool to get a job done. Hobbyist-breeders of high quality stock will find themselves concerned with attaining specific goals for their birds. By applying the basic principles of heredity and selectively pairing the different types of mutations together one can know beforehand what to expect in the nestbox.

Propagation of different colors, the ability to sex chicks, and breeding to conform to a show standard are all high priority items for serious breeders. Our primary focus here will be utilizing different color mutations to obtain desired results and, hopefully, answer common questions. Along the way some of the common errors should also be cleared up.

One nice thing about working with parrot-type birds is the similarities in their colors and how these traits are passed on from one generation to the next. Dominant, recessive, and sex-linked mutations find parallels in cockatiels, budgies, lovebirds, ringnecks, amazons, lineolateds, etc. For this reason it is logical that future aviculturists can expect to see many of the same colors showing up in the less established species as we now see in the lovebird and budgerigar. In many of the less domesticated species of parrot a new color showing up in a clutch is cause for much excitement and celebration. Among aviculturists these are very valuable birds!

Sometimes a mutation showing much the same genetic and visual properties will be

called by different names on different species. The opaline budgie and pearl cockatiel exhibit much the same melanin deficiency pattern in the feathers and both are also genetically sex-linked. Conversely, the mutation called “Fallow” is said to be recessive in cockatiels but sex-linked in Green Cheeked conures – how confusing!

I believe the easiest way to illustrate the concepts involved is simply to answer a few of the practical questions asked by fellow breeders. For those who wish to find their own answers to other questions there is a listing of possible matings and outcomes shown in a way the average person can follow. All you have to do is pick a single mutation you wish to know about and "plug it” into the following lists of matings. As will be made clear, the results of these crosses apply equally well to any mutation with similar genetic properties found in many different species of parrot. By the way, all the answers and solutions to the questions and crosses involve only a single mutation. In real life other colors could pop up from unknown carriers of other traits.

Just in case you didn't know:

“NORMAL” refers to the wild form of any trait. This wild form is usually dominant but not always so.

A “VISUAL” bird shows the mutation but a “CARRIER”or “SPLIT”does not.

“FACTOR” is a layman's term for a gene or allele carrying the desired trait.

Therefore the terms SINGLE FACTOR, CARRIER or SPLIT all describe the “HETEROZYGOUS”condition of having one mutant gene paired with a normal gene.

“DOUBLE FACTOR” refers to a pair of two identical or “HOMOZYGOUS”genes carrying the same trait.

“PHENOTYPE” is simply what the bird visually looks like.

“GENOTYPE” describes the genetic composition.

"SEX-LINKED" traits seem to be fairly common in birds so let's start with the pairing of any one sex-linked color. (All mutations showing these results are found on the sex chromosome which determines the sex in higher forms of life, hence the name sex-linked.) In birds, males have a double set of complete sex chromosomes where hens have only one complete set. (The reverse is true in mammals.)

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SEX-LINKED QUESTIONS:

1. Question: I have a pearl hen paired with a normal cock. Will I get any visual pearl babies?

1. Answer: Maybe, it all depends on if the cock is carrying the pearl. If he is you can get 50% pearls and 50% normals of either sex but if he is not "split" to pearl all of your chicks will be normal.

2. Question: How can you guarantee the sex of a baby cockatiel while it is in the nest?

2. Answer: Normal gray chicks are very difficult to sex but with knowledge of how sex-linked traits work it becomes a 100% guarantee for the seller. Simply pair a cock showing any sex-linked color with a hen not showing that same color, then all the daughters will show it but the sons won't. All the normal birds must be cocks carrying the trait from the mother but they will still look completely normal.

3. Question: I have a pair of normal Peach Faced lovebirds and I found a lutino baby in the nest. How did this happen?

3. Answer: Simple, The father must be carrying the gene for lutino which he passed on. Statistically 50% of his babies will carry this gene. Among those that do, only hens can show the color from a pairing of normal looking birds. Therefore, 50% of the cock siblings will be "split" for lutino and another 50% will not receive the mutation at all. None of the cocks will show the trait. Only by breeding these cocks can you tell if they are indeed "split" to lutino.

4. Question: It sounds simple to produce hens displaying a sex-linked color. How do

you produce males showing it?

4. Answer: You're right, there are more ways to get hens than cocks showing sexlinked colors. The trick for producing cocks is to pair a hen showing the desired trait

to a cock either showing it or carrying it. In order for a baby cock to show any sexlinked trait he must have gotten the allele (the mutation site on the gene) from both

his parents. If the father is only "split" 50% of the babies will show it and be of either

sex. Of the chicks looking normal, all the cocks must be "split", as they would inherit

the trait from the mother.

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Here are a few rules to follow when dealing with sex-linked properties.

SEX-LINKED RULES:

I. NO HEN CAN BE "SPLIT" TO OR CARRY A SEX-LINKED TRAIT: If she

doesn't show it she doesn't have it.

II. ALL HENS GET SEX-LINKED TRAITS FROM THEIR FATHER: A visual

cock has two alleles whereas a hen can only carry one. Therefore, a daughter must

have received her one allele on her single sex chromosome from her father. (If she

had gotten two, one from each parent, the bird would be male.)

From this it follows that a double factor visual cock paired with a normal hen will

result in all daughters showing the sex-linked trait, but no sons. These sons will all

carry the allele but not show it. Conversely, a visual hen paired with a normal cock

will only produce normal colored "split" sons and normal daughters, but no visuals.

Once again this is the key for sexing babies. Pair a sex-linked visual cock with a nonvisual hen.

III. COCKS CAN BE VISUAL OR "SPLIT": To show a visual trait a cock must

receive it from both parents (much like a non-sex-linked recessive trait requires).

Remember in sex-linked genetics this only applies to cocks - not hens. (Of course,

this assumes the trait we're dealing with is sex-linked recessive, not all of them are!)

Once you understand sex-linked rules and regulations, recessive and dominance is

easy. Next we're going to deal with AUTOSOMAL or "body forming" chromosomes in which both sexes have the same double pairing. There is no need to worry about cocks and hens as different examples because hens carry the double dose too.

Here are some questions illustrating the mechanics of simple dominant-recessive inheritance.

DOMINANT-RECESSIVE QUESTIONS:

1. Question: A pair of green budgies produced a blue chick. How come?

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1. Answer: Even though both parents look pure green, genetically they are not. To produce any recessive trait such as blue a chick must receive a blue allele from each parent. This means the parents must both be "split" to blue.

Your chance of getting more blue chicks is 25%. The remaining green chicks have a 66.6% chance of carrying the blue gene (heterozygous) but will look identical to the 33.3% green chicks not "split" but having a set of two green genes or alleles (homozygous). Only by breeding these green chicks with mates having one or two blue alleles will you know which is which. If there ever is a blue (recessive) chick from a green (dominant) parent, that parent bird is carrying the recessive trait from one of it’s own parents.

2. Question: I have a blue Indian ringneck paired with a normal green and am not getting any blue chicks. Why?

2. Answer: Green is dominant over blue so a visual blue chick must have a set of two blue genes, one from each parent, to show blue. If the green parent is not heterozygous to blue it has no blue allele to pass to the offspring. I can guarantee all of the chicks are "split" to blue so when paired to blue carrying mates they will have either a 25% or 50% chance of producing blue chicks. (These odds reflect the pairing of either a split or visual blue to a split to blue mate.)

DOMINANT / RECESSIVE RULES:

I. DOMINANT TRAITS HIDE RECESSIVE TRAITS. If an animal or plant has a dominant gene paired with a recessive gene (heterozygous or "split") only the dominant feature will show up.

II. A RECESSIVE TRAIT MUST BE GENETICALLY PRESENT IN BOTH PARENTS BEFORE OFFSPRING CAN SHOW IT. A fertilized egg (zygote) receives a single set of chromosomes from each parent. To show a visual recessive mutation the zygote must have two recessive alleles. If it only receives one recessive its 2nd gene or allele will mask it, which by default is dominant.

Here is a quick reference guide to help you pair your stock correctly. To get the desired results all you need to know is which traits are dominant, sex-linked, or recessive. Of course all theoretical outcomes reflect statistical probabilities. Some clutches will probably not show these expected ratios but it will all work out over the long run.

1. Use any dominant or recessive trait.

2. Select the pairing of your choice from the dominant and recessive pairing combinations below.

3. “Plug in” your particular dominant or recessive trait to see how it works out.

DOMINANT TRAITS: (autosomal non-sex-linked) include MOST WILD COLORS, DOMINANT PIED in budgies, AUSTRALIAN GREY in budgies, DOMINANT SILVER in cockatiels etc.

RECESSIVE TRAITS: (autosomal) include PIED or HARLEQUIN, BLUE - WHITEFACE, in budgies and tiels; WHITEBREAST, BLUE and YELLOW HEADED in Gouldians etc.

DOMINANT & RECESSIVE

TRAIT PAIRING COMBINATIONS AND RESULTS:

1. Dominant double factor (homozygous) mated to a dominant double factor or

dominant single factor "split" to a recessive.

RESULT = 100% dominant looking chicks.

2. Dominant double factor (homozygous) mated to a recessive double factor (homozygous).

RESULT = 100% dominant single factor (heterozygous) babies carrying the recessive but showing the dominant color.

3. Recessive single factor " split" to dominant mated to a recessive single factor "split" to dominant (both heterozygous birds carrying one dominant and one recessive allele).

RESULT = 75% dominant and 25% visual recessive (homozygous) chicks in the nest.

4. Recessive single factor / dominant (heterozygous) mated to a recessive double factor (homozygous)

RESULT = 50 % dominant single factor "splits" and 50 % recessive visuals.

5. Recessive double factor visual mated to a recessive double factor visual.

RESULT = 100% visual homozygous recessive chicks.

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SEX - LINKED RECESSIVE

TRAIT COMBINATION PAIRINGS AND RESULTS:

SEX-LINKED RECESSIVE TRAITS inc. LUTINO, PEARL, OPALINE, CINAMIN, in tiels and budgies, ROSY in Bourkes etc.

Pick any Sex-Linked trait,”plug it” into the pairing of your choice and check out the outcome.

1. Sex-linked visual double factor cock mated to a normal hen.

RESULT = 50% normal cocks carrying the sex-linked color and 50% hens all showing the sex-linked color. All babies are sexable as soon as you see the color on the feathers.

2. Sex-linked visual double factor cock mated to a sex-linked visual (must be

single factor) hen.

RESULT = 100% sex-linked visual chicks of either sex.

3. Sex-linked single factor (non-visual) cock mated to a normal hen.

RESULT = 25% normal homozygous cocks, 25% normal cocks "split" to

the Sex-Linked color, 25% visual hens showing the sex-linked color, 25% normal

hens. This translates to 75% normal birds and 25% sex-linked colored birds. All

the colored sex-linked babies are hens but the normals are not sexable by sight.

Also 50% of the normal colored males will be split for the sex-linked trait and

50% will not carry it at all.

4. Sex-linked single factor (non-visual) cock mated to a sex-linked single factor

(visual) hen.

RESULT = 50% sex-linked visual birds of either sex and 50% normal

colored babies. All of the normal colored cocks will be "split" for the sexlinked color.

5. Normal cock mated to a sex-linked visual hen.

RESULT = 100% normal offspring. The sons will all be carrying the sexlinked gene but will all look normal.

Now that we have run through the possible different pairing combinations and

statistical outcomes of single mutation matings let's apply this to a real situation.

A breeder-friend excitedly showed me what appeared to be a lutino Sun conure chick

that came out of normal looking parents. Various "expert" breeders advised her to

breed this chick to a sibling to produce more lutinos. There are two good reasons why

this practice should not be followed.

First: if your goal is to breed the strongest chicks possible you should avoid

inbreeding as much as possible. Contrary to the beliefs of many, brother-sister

matings are less desirable than breeding back to the parent.

Look at it this way. Common sense should tell us that birds having two different

parents or even one different parent should be more distantly related than siblings sharing both parents. Although breeding back to a parent is still considered close inbreeding, you are still bringing in more genetic diversity from a previous generation. This is certainly better than breeding together two individuals sharing both parents and thus the same genetic source from both sides!

Second: If your goal is to pair your birds to provide the greatest chance of producing a desired trait, it is much better to mate the desirable chick to a parent proven to carry the color (he produced the chick) rather than to a sibling who might be carrying it.

Let's look at this chick that might be a lutino Sun conure. There are a couple of basic questions that must be asked.

1. Question: Is this mutation dominant, recessive, or sex-linked?

1. Answer: Since this chick came from a set of normal looking parents from different bloodlines and mutations at this time are relatively rare in Sun conures the easiest way for a mutation to pop up would be for a sex-linked single factor cock to pass it on to a daughter. (See sex-linked trait pairings

Since both parents look normal we can rule out a dominant allele and since a recessive trait requires it’s presence in both parents to produce a visual chick (see Dominant / Recessive Rules) it is unlikely to be recessive. Also, the chick looks like a lutino and lutino has a consistent history of being sex-linked in other species of parrots. I would suspect this mutation is sex-linked.

2. Question: How should this chick be bred to gain the greatest chance of producing more lutinos?

2. Answer: Assuming we are dealing with a sex-linked trait we must also assume the lutino chick is a hen. The best option is to breed her back to the father who we know is carrying the mutation.

As you can see, a little common sense paired with a basic understanding of genetics

can help you work out some of the many everyday problems confronted by the average breeder. It is hoped that as you work with applying the above pairings and results to your own birds that, with practice, you will begin to understand and appreciate a small part of the wonder to be seen in the natural world. How fortunate we are to have this opportunity to serve and respect the natural order around us!

Yet, we are not done - not even close. I cannot think of a subject more befitting to the belief "The more we know, the more we know we don't know", than genetics. The basic premise is beautifully simple but the applications of this simplicity becomes challengingly complicated in a hurry, especially when in the real world of multiple traits and multiple properties.

ALBINO: A TWO-FACTOR TRAIT

“Found in cockatiels, budgies, ringnecks etc.”

Let us begin with a combination of two traits and properties called the albino. What it is and how it is produced.

The albino form is not a single mutation at all. It is a combination of two very different traits, lutino which is sex-linked and blue or whiteface, which is recessive. The lutino factor takes away the dark melanin resulting in a yellow bird with pink eyes.

The whiteface factor in cockatiels removes the yellow pigment in much the same way as we see in the blue budgie. Since a normal cockatiel is not green the result, when yellow pigment is removed, is a gray and white bird. Both mutations working together in budgies and cockatiels produces a beautiful snow white bird with no yellow or dark markings.

Obviously if one wishes to breed this type of albino it is essential to keep track of both sets of alleles and their different properties in both parents. The easiest way to do this is to look at an albino cockatiel, budgie, ringneck, etc. as the result of seeing

two separate traits working independently of each other on the same bird; one is sexlinked, the other is recessive.

Plug in the blue-whiteface into the recessive matings and lutino into the sex-linked matings and then combine the two outcomes.

As an example let's pair a visual lutino "split" to whiteface cock with a whiteface hen. The cock must be a double factor lutino to show the trait while the hen cannot carry a sex-linked trait at all unless she shows it (see Ex. #1 Sex-Linked Pairings). Due to the "lutino" factor all the chicks will be sexable. The recessive whiteface must also be present in both parents to produce whiteface or albino.

In our example we have paired a visual lutino/"split" whiteface cock with a double factor whiteface hen (see Ex. #4 Dominant/Recessive Trait Pairings). 50% of the offspring of either sex will show whiteface and 50% will be heterozygous nonwhiteface normals. Combining the results of these two traits gives us the answer to the number of albinos expected in the nest.

Since we know 50% of the clutch will be daughters who in turn must be lutino and 50% of all chicks statistically will show whiteface, that leaves us with 25% of the clutch showing up as albino daughters.

CINNAMIN PEARL:

Don’t let this combination fool you.

A common misconception among cockatiel breeders is the idea that two separate mutations, namely pearl and cinnamon, combine to form one indivisible single cinnamon-pearl trait. In other words, a bird with both cinnamon and pearl can produce only cinnamon-pearls with no single trait cinnamons or pearls in the nest.

Two separate traits combining to form one is extremely rare and does not happen in this case. It is true that a double factor cinnamon-pearl cock will only produce cinnamon-pearl daughters but these traits are passed on independently of each other.

A simple test is to mate a cock "split" to both cinnamon and pearl with any hen. You will indeed over time see cinnamon only, pearl only, cinnamon-pearl and normal gray

chicks.

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VIOLET: A THREE-FACTOR TRAIT.

Now let's look at a color requiring a set of three different traits to be present in the right proportions for it to show up. The violet allele is in itself a dominant autosomal mutation that is also lethal (if a baby receives two violet alleles it dies). Also, for the true violet color to show, the trait must be present on a cobalt blue bird. If violet is present on a homozygous sky blue bird lacking one dark-factor allele then the bird will look much like cobalt but will actually be a sky blue violet.

Here is an example of how to simplify what appears to be a complex question.

Question: I have a pair of green budgies and I found a violet chick in the nest. How did this happen?

Answer:

1. First, in order for a pair of green birds to have a blue chick, both parents must be "split" to blue.

2. Second, visual violet requires just one dark-factor for it to show up.

This can come from either parent.

3. Third, violet is dominant so this single gene on cobalt will automatically give violet. Violet can also be passed on from either parent.

Now let’s move on and look at a few examples of mutations that do not neatly categorize themselves as dominant or recessive. These PARTIAL DOMINANTS can be found on either the autosomal or sex determining chromosomes.

PARTIAL DOMINANT AUTOSOMAL

“DARK FACTORS”

Found commonly in budgies and appearing now in many other species of parrot, is an autosomal non-sex-linked trait that is neither dominant nor recessive. It is instead classified as a “PARTIAL DOMINANT” exhibiting characteristics in between the

two.

Unlike what is seen in the familiar dominant / recessive scheme of things a SINGLE FACTOR HETEROZYGOUS CARRIER LOOKS DIFFERENT THAN A DOUBLE FACTOR HOMOZYGOUS BIRD. In other words, on a blue budgie, we see a non-dark-factor bird referred to as "sky blue".

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A single-dark-factor bird, showing an intermediate darker shade of blue is called a "cobalt"; and the bird having the double-dark-factor set of genes is described as "mauve". A pair of "cobalts" will produce 25% "sky blue", 50% "cobalt", and 25% "mauve" chicks.

“SPANGLED BUDGIES”

Here is another impressive mutation found in the ever-popular budgie. A single factor of this partially dominant autosomal allele is all that is needed to show a beautiful "spangle" pattern on the back and wings of either sex. A double dose of this mutation hides most of the coloring of the bird, some might mistake it for a "black eyed clear" or even a "lutino", but the single "split" dose only partly reduces the darker colors creating the sought after "spangle" effect.

SEX-LINKED DOMINANT:

“in Red Headed Gouldian finches”

As alluded to earlier, there exists a relatively unusual form of sex-linked expression, which is dominant. Many writers fail to differentiate between recessive and dominant sex-linked traits, assuming all are recessive, but I believe that is a mistake. Red head genetic properties in Gouldian finches are an example why.

In accordance with sex-linked rules cock birds can either carry one or two factors for a given trait on each of their two sex chromosomes. Heterozygous birds (cocks having one mutation allele paired with a normal allele) will show red headed color instead of it being masked by the non-mutation gene. Hens, of course, cannot be

hidden carriers so must express the red head if they have it. With this difference in mind, red head can be added to the list of sex-linked traits.

A note of interest; both red headed and black headed Gouldians are found in wild populations yet both colors respectively exhibit dominant or recessive sex-linked genetic traits. Some authorities classify them as separate color forms within the same species. With red head being dominant but only seen in 25% of wild Gouldians we may be witnessing a new development in the “normal” wild Gouldian finch.

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SEX-LINKED PARTIAL DOMINANT:

“IN YELLOW BODIED GOULDIAN FINCHES”

This is a SEX-LINKED INCOMPLETE or PARTIALLY DOMINANT trait. A single factor cock will exhibit a partial dilute form of yellow-body while a hen (being only a single factor) cannot be dilute but must express fully the yellow-body coloration on her single sex chromosome; a double factor cock displays a full yellow -body.

It follows then that a double factor cock mated to a normal hen will produce all dilute sons and yellow-body daughters. A note of interest; the recessive white-breast allele mutation in Gouldians enhances the yellow-body factor. A genetic single factor dilute male showing white-breast looks like its double factor yellow-body brother!

Congratulations!

You have completed "Genetics For Novice Pet Bird Breeders” #101.

Now please feel free to “plug, in, and play” as needed to work out your own challenges.

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