GENETICS FOR AVICULTURISTS

Recent Mutations in Cockatiels

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Introduction

A dramatic increase in Cockatiel color mutations over the last decade has spiraled forth a plethora of myriad color combinations. It is no longer a simple task to outline or discuss individual Cockatiel mutations, as the number of colors and patterns continues to grow, challenging Cockatiel breeders and enthusiasts to keep pace. One paper cannot begin to cover each individual new mutation, and its now multitudinous combinations, to the depth and degree which would do each one justice. Instead, this paper will limit its scope to discussing each new major mutation by category, and attempt to provide a basis for which the mutation can best be understood, and applied to the growing number of cross, triple and multiple color combinations.

Mutation Modes

Spontaneous Mutations

Mutations commonly arise in aviaries under one of two conditions. In the majority of mutations, the affected trait usually occurs as a sudden variation of an inherited characteristic. Such color mutations are usually a welcome surprise to the breeder and are so different or obviously deviant, that anyone slightly familiar with the basic colors will recognize its unnatural and anomalous appearance almost immediately.

Selective Breeding

The second less commonly seen mutation which must be considered is the gradual appearance of an unusual trait which, through painstaking work and diligence, arrives at its final form only after many years of work. This gradual and timely process which the aviculturist controls by deliberate pairing of affected individuals, is better known as selective breeding. For example, the deliberate pairing of very yellow Pied stock, correctly linebred, will usually yield a predominant strain of heavy yellow "golden" Pieds.

Inheritance

The majority of Cockatiel mutations, until very recently, dealt only with autosomal recessive inheritance (ie. Pied, Fallow, Recessive Silver, Whiteface, etc.) or sex-linked recessive inheritance (e.g. Lutino, Cinnamon, Pearl, etc.). More recently, with the advent of the U.K.'s new Dominant Silver mutation, a new mode of inheritance in Cockatiels was introduced known as the dominant mode of reproduction. What makes dominant inheritance even more interesting is the appearance of both single factor and double factor birds which, like any other mode, is predictable by Mendel's laws of inheritance.

More specifically, Mendel's law of dominance states that one factor in a pair of traits dominates the other in inheritance, unless both factors in the pair are recessive. This works as well for any mutation or trait recessive to the Normal Gray (i.e. including both recessive autosomes and recessive sex-linked traits), but takes on new meaning for dominant, codominant and partially dominant mutations. Although the dominant mode of inheritance is new to Cockatiels, dominant inheritance is routinely worked within other species in aviculture, including Budgerigars, lovebirds, Indian Ringnecked Parakeets and others.

Color Pigmentation

For the purpose of this discussion, we will divide Cockatiel color pigments into two major groups.

The first group, melanins, is comprised of the darker or shaded pigments as found in the ground colors of standard mutations e.g. gray, cinnamon, silver, fallow, etc. The second group, carotenoids, is composed of the red-yellow-orange pigments occasionally referred to as lipochromes. The third listing is simply headed as white which, for the sake of this discussion, is the absence of pigment and is therefore simply, the absence of all color.

- Melanins: any of the group of darker or shaded pigments, e.g. gray, cinnamon, silver, fallow, etc. Melanins may vary in shade and intensity which breeders commonly refer to as the lack, or presence, of dark factors.
- Carotenoids: any of the group of red and yellow pigments, often referred to as lipochromes, when discussing orange and yellow coloration.
- White is the lack of pigment or absence of all color.

Spontaneous Mutations

Whiteface

No discussion of recent mutations in Cockatiels would be complete without addressing the arrival and effect of the Whiteface mutation. Although appearing as a spontaneous mutation in Europe during the mid-1970s, the Whiteface mutation was imported into the United States in the early 1980s by American aviculturist, Dale R. Thompson, who recognized the importance of the variety and the dramatic impact it would have on future combinations.

The Whiteface Cockatiel is not only a relatively new color variety, but the rules governing its color production are exceptional. While the Normal Gray varies in color depth (e.g. dark factors), the Whiteface, or Charcoal Cockatiel (as it was originally named in Europe), has a sooty "charcoal" color appearance. It differs from all other existing mutations in that it voids the variety of all carotenoids, or

orange and yellow pigment. Hence, the absence of the characteristic yellow mask of the male, yellow facial spottings on the hen, and yellow spottings under wing flights, and tail barrings, on hens and immature young.

Nor, do either sex carry the usual orange ear covert "cheek patch" feathers. These areas, are all instead, replaced by white. In fact, upon close inspection of the hen's now absent orange cheek patch, one can detect a faint outline or overlay of whitish feathering. Upon maturity, males develop the white facial mask, while hens replace any yellow pigment on the face with white. Once again, yellow flight feather spottings and undertail barrings are also replaced by white.

Whiteface Cross Mutations

While the Whiteface is indeed a handsome and elegant mutation, the real drama unfolds as the variety is bred into other existing mutations, when correctly paired. Within the first few years of its appearance, around the mid-to-late 1980s, cross and multiple Whiteface mutations have appeared which integrated the standard colors. Some of the more popular combinations have been the appearance of Whiteface-Pied, Whiteface-Pearl, and Whiteface-Pearl-Pied, which, like snowflakes, (and owing to the distinctly varying Pied and Pearl patterns), are uniquely individual, with no two birds marked exactly alike.

Also intriguing, and slightly less available, are the Whiteface-Cinnamon, Whiteface-Cinnamon-Pearl, Whiteface-Cinnamon-Pied and Whiteface-Cinnamon-Pearl-Pied. However, their lesser availability may be due, in part, to two principal reasons. First, the Whiteface-Cinnamon varieties may be somewhat overshadowed by the more "showy" splash of the Whiteface-Pied and Whiteface-Pearl-Pied. Second, both triple and quadruple crosses (e.g. Whiteface-Cinnamon-Pearl, Whiteface-Cinnamon-Pied and Whiteface-Cinnamon-Pearl-Pied) generally take longer to produce (i.e. multiple filial generations will be required unless all traits are present in the genotype of the cock and the hen in the parental generation).

Yet, the more difficult crosses are, in fact, the double recessives (e.g. Whiteface-Pied) which usually include the "rarer," or new, recessive mutations. Some such rares include the Whiteface-Fallow, Whiteface-Recessive Silver and the triple recessive, Whiteface-Silver-Fallow. Unfortunately, such recessives usually deal with two major inherited problems. First, double recessives have the disadvantage of "downsizing," or exhibiting diminished size. This is not uncommon, and is especially prevalent in many new, single, recessive mutations in aviculture.

Such compromised recessives may be inherently weak, combat lethal factors, or other problems, especially among red-eyed mutations. Knowledgeable line-breeding techniques, successfully employed, have often overcome such difficulties, but this is usually so only when the problem is approached by a seasoned, knowledgeable aviculturist. When working with a double recessive, the challenge may be far more difficult, unless, perhaps, each color has been worked with individually to correct any inherent weakness, before the recessives are combined.

It is generally understood among color breeders that one of the advantages of working with sex linked mutations is the mutations' linkage with size. For example, working the Whiteface mutation into an established strong Pearl bloodline which normally produces large individuals, will eventually bring the cross mutation (i.e. Whiteface-Pearl), up to size, while adding hybrid vigor to improve the variety. While this may be accomplished with an exceptional outcross, it is generally only achieved and maintained through the use of healthy, vigorous, linebred stock.

The second disadvantage is one of color. When using such colors as Fallow, or Recessive Silver, etc. there is an increased dilution in the ground color, especially when other mutations are combined. Although not always fully obvious on its own, the diluted effect may be even more readily apparent in future combinations. Dilution is simply mentioned as a disadvantage should it effect colors producing results which do not conform to existing show standards. However, they may very well become pleasing and unusual color combinations of the future we have yet to recognize.

Albino

As yet, there is no spontaneous mutation in Cockatiels which produces an Albino, i.e. an all-white, red-eyed bird with pink beak and feet coloration. However, the man made crossmutation, known as Whiteface-Lutino, results in a stark white bird of the above description. Here, the Whiteface mutation acts to remove any trace of yellow and orange carotenoid pigment; while the Lutino mutation acts to mask the melanin or gray pigment. The result is a snow white bird, with red eyes, pink feet and beak in both sexes. Albeit, a double or cross-mutation.

It must be understood that simply pairing one color to the other does not instantaneously produce Whiteface-Lutinos in the first generation. Rather, it takes two or more generations to pro-

duce this mutation, depending upon the genotype, or genes carried by the parental generation. It is my personal opinion that one day we will produce a spontaneous homozygous Albino in pure form, which does not have to be combined as we now have with the Whiteface-Lutino.

Recessive Silver

The Recessive Silver appeared in continental Europe during the late 1960s and was the first of the rare recessive mutations to appear after the Pied. A wide fluctuation in color exists among individuals of this variety. In the Recessive Silver, the melanin pigment is modified and can appear as a steel or silvery-gray, to a fawnish-brown tone. Most individuals have red depigmented eyes, while others acquire additional melanin and appear more brown. When crossed with other mutations, the Recessive Silver may act as a dilute.

The original Silvers of Europe are reported to have had difficulty reproducing, as well as a high incidence of inherent blindness. This understandably put a damper on the enthusiasm of the American aviculturists. Eventually, however, the Recessive Silver did receive some attention among color breeders here in the U.S. once the incidence of blindness was overcome. Whether the Recessive Silvers of today are from the original shipments from Europe, or rose from new U.S. strains unrelated to European stock, has never been known. Although not a recent mutation, it is only in recent years that it has become available to most breeders. While it is still far from being a popular variety, it is still listed under show classifications in the "Rare" section, as are its many combinations.

U.S. Platinum

By combining the Recessive Silver with Fallow (also a recessive), U.S. breeders produced a metallic combination during the mid-1980s which has informally been dubbed, the Platinum. Here, the overall light tannish-buff ground color of the Fallow, with its red eyes, vivid yellow facial mask in both sexes, and suffusion of yellow carotenoids extending down the breast and abdomen of hens, also produces a diluting effect. This dilution acts to "wash out" other colors when breeding the Fallow to other mutations. When crossed to the already dilute Recessive Silver, it creates a light metallic effect. Breeders who choose to call this combination by its unofficial nickname rather than its genotype, Recessive Silver-Fallow, must be certain not to confuse it with the United Kingdom's Platinum (also a cross-mutation), or the Australian Platinum, which is currently considered a single spontaneous mutation.

Dominant Silver

The Dominant Silver is currently the first, and only, dominant mutation in Cockatiels. It first appeared in the aviaries of Terry Cole, in the United Kingdom, during the early 1980s. By 1988, Cole established the strain and bred the Dominant Silver with many of the standard varieties to produce new double and triple cross-mutations. In

fact, while up to this point the United States could take credit for producing three Cockatiel mutations (i.e. Pied, Lutino and Fallow), the United Kingdom is now credited with producing its first new Cockatiel mutation, as well as the first dominant mutation ever established in Cockatiel color genetics. Fortunately for U.S. breeders, Dominant Silvers were imported into the U.S. in the early 1990s.

The interesting feature to dominant inheritance is the occurrence of single factor and double factor genotypes. Phenotypically, a single factor Dominant Silver appears as a pastel-silver shade of gray, somewhat darker on the head and neck, creating an appearance of a "skullcap." Some birds carry brighter carotenoid pigment in the orange "cheek patches" and yellow facial mask. All birds have the telltale black eyes and dark, pigmented legs and feet, which are the hallmark of the Dominant Silver (Recessive Silvers have the depigmented red-eyes and pink feet of that variety).

Double factor Dominant Silvers experience a further dilution. The reduction of melanin is almost so complete that individuals appear as Lutinos with only a light grayish body wash, including the darker skullcap and pigmented eyes and feet. As a dominant mutation, the Dominant Silver cannot be carried by a Cockatiel as a heterozygous recessive or in "split" form. Either a Cockatiel is a Dominant Silver, or it is not. For those who are interested, a full account of the Dominant Silver and its breeding genetics appears in an article by the author "*The New Dominant Silver Mutation of Europe*," in the February-March 1991 edition of AFA *Watchbird*.

U.K.Platinum

As the original breeder of the Dominant Silver, Cole worked the Dominant Silver into the recessive Whiteface mutation to produce the new cross-mutation, Whiteface-Dominant Silver. Cole felt the Whiteface version of the Dominant Silver was the most pleasing combination to date, and suggested the name, "Platinum," since birds appear more metallic after losing the yellow carotenoid pigment caused by the introduction of the Whiteface mutation. The Whiteface mutation also eradicates the orange ear covert or "cheek patch" feathers of the U.K. Platinum

As mentioned above, some U.S. aviculturists are already calling the American Recessive Silver-Fallow by the nickname, Platinum. Clearly, a following and agreement on classic mutation nomenclature should be defined, and adhered to, to eradicate any possible confusion between aviculturists and other countries.

German Yellow-cheek or Yellow-face

The sex-linked Yellow-cheek mutation carries an unmistakable, vivid yellow "cheek patch," replacing the usual orange ear covert feathers found in standard mutations. A first for mutation hens, Yellow-cheek females also carry the brilliant golden cheek patch. This vivid coloring replaces the hen's formerly dull-orange ear covert feathers, corresponding to the blazing orange cheek patch found in most standard mutations of their male counterpart. Such color changes are consistent with carotenoid pigments already present in the species and in fact, some breeders feel the yellow of the German Yellow-cheeks is much brighter than the yellow pigment found in standard mutations, and involves the entire body. Surrounding the golden cheek patch in adult males, is the bright lemon mask, tempting many to call the variety, Yellow-face.

Interestingly, it is thought that the first shipment of Yellow-cheeks into the U.S. was received in Florida sometime during 1991 or 1992 at the latest. The following year several large shipments of Yellow-cheeked Cockatiels were received into the U.S. with the assistance of U.S. aviculturist, Dr. Reiner Erhart (who is credited for importing the first Cinnamon and Pearl Cockatiel mutations from Europe into the United States, 20 years earlier).

U.K. Pastel-face

Another first, the United Kingdom's Pastel-face joins the Cockatiel with other avicultural species which juggle recessive mutations within a hierarchy of dominant relationships. While prior recessive mutations in Cockatiels (i.e. Pied, Fallow, Recessive Silver and Whiteface) combine within the same individual, the Pastel-face behaves differently. Although acting as a recessive autosome genetically, the Pastel-face is dominant to Whiteface, while recessive to the Normal Gray. Whether this may be extrapolated to other colors, (e.g. Recessive Silver, etc.) remains to be seen. Such efforts will only be known, or proven, when breeding results are reported by a large number of breeders over time. The Pastel-face was imported into the U.S. around the same time as the U.K.'s Dominant Silver.

The recessive Pastel-face may in fact be more than just a facial mutation. First bred by Bob Crossley (son-in-law of Terry Cole who was credited with breeding the Dominant Silver, both of whom are from the U.K.), the change in pigment is seen throughout the bird. It differs from standard varieties by carrying a pale lemon face and peach cheek patches, while it is claimed the males maintain an intense deep body color. Since the entire body is affected, the Pastel-face, at least in the Normal Gray, is affected by changes in both carotenoid and melanin pigments.

Australian Platinum

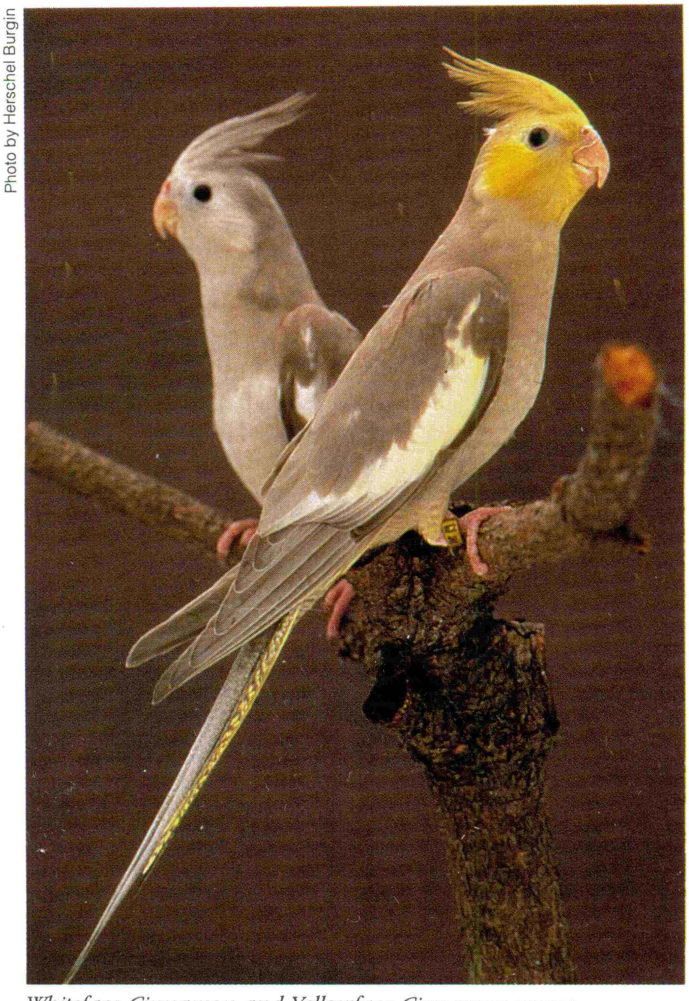
The Platinum is a sex-linked recessive mutation of extreme dilution and has been described as having a pale, smokey gray body color. In addition, an underlying heavy yellow suffusion appears throughout most of the body, with normal appearing carotenoids coloring the face and crest. Some authors have noted that cock birds become darker with maturity. One identifying feature of the Australian Platinum is the smokey gray body color also appearing on the primary flight and central tail feathers. This appears to carry over when the Platinum is crossed with other color mutations.

Any variance in the Platinum, when crossed to other mutations, appears to be explainable when considering a bird's full genotype. In Australia, Platinums have been crossed with the Lutino (with full to partial masking), and the Cinnamon (a dilute), which has produced double and triple mutations. As found in other sex-linked

Photo by Herschel Burgin

Whiteface-Recessive Silver-Pied cock.

Photo by Herschel Burgin



Whiteface-Cinnamon and Yellowface-Cinnamon young.

Photo by Herschel Burgin

Single Factor Dominant Silver cock owned by Dave Okura.

Photo by Lloyd's Photography, courtesy of Margie Mason

New U.S. mutation (light cock and darker hen).

Photo by Herschel Burgin

Whiteface-Pearl-Pied cock.

Photo by Herschel Burgin

Yellowface-Cinnamon-Pearl-Pied hen.

mutations, it appears the Platinum can combine visually to produce many crosses, although there may be a wider variance in the phenotypical appearance of some colors (e.g. Lutino-Cinnamon-Platinums, etc.). When crossed with color patterns, e.g. Pied, Pearl, etc. the reports of such outcomes have been positive. In Australia, the Platinum is a strong, viable mutation, without evidence of infertility or lethal factors. Such often is the case with sex-linked mutations.

Australian Spangle

The Silver Spangle of Australia is an autosomal recessive mutation incorporating both a color and a pattern change. It is not yet understood whether there may be single and double factor birds, although a small percentage of lighter cock birds have been produced. It has been noted that in these lighter silver birds, the yellow carotenoid pigment is correspondingly reduced to a light yellow suffusion. Some of the early Spangles have been reported with inherited lethal factors.

Silver Spangles have a silver body color with striated, shaded gray in both dark and light shades, in individual feather barbs. The head is less shaded compared with the rest of the body, with silver shading on the shoulders, mantle, back and wings. One of the distinctive features of the Silver Spangle is the reduction of the typical white wing-bar which, is also silver shaded, with heavily marked individuals losing the formerly white wing-bar in its entirety.

Selective Breeding

Melanistic

Over the years there have been occasional sightings and claims of predominantly black Cockatiels. One bird I recently viewed had such a dark intensity that it did appear to be almost entirely black, with a yellow mask and orange cheek patches. The following are only some of the genetic possibilities. The bird may have mutated a darker pigment than the standard dark factor Normal Gray, such as a dark, black, eumelanin pigment. Or, an induced melanism may have produced a temporary black pigment, caused from ingesting excessively oily feeds. The bird could be a melanin morph, which is uncommon in parrot species and usually only found in certain families and orders such as hawks, some landbirds, etc. Or, the bird could be the end result of purposeful line breeding efforts by pairing the darkest Normal Grays together. Test breeding and rigid recordkeeping can assist in determining if the latter is true.

Carotenoid

Carotenoids in birds, such as xanthophylls and carotenes include yellow, orange, red, and red-orange pigments. Carotenism can influence both the intensity and distribution of these pigments. Purposeful selection of heavy yellow birds in the production of specific mutations, by line breeding techniques, have developed enhanced strains, at least as measured by color. For example, heavy "golden" Pearls; yellow "buttercup" Lutinos; and other "yellow overlays" have been developed.

New U.S. Mutation

Melanin Schizochroism

There is much current controversy over the newest U.S. mutation(s). The predominant breeder, Margie Mason, acquired the mutation some years ago from an individual who wished for her to work with the birds, and she is justly concerned over the final name or nomenclature decided. Further, there has been much speculation as to whether the color and pattern change stem from only one mutation, (e.g. single and double factor birds); or if there are two (or more) separate mutations at work. Suggestions have ranged from the Australian Recessive Silver Spangle Dilute with heavy yellow suffusion, to Australian Platinums. However, the (often misused) term "dilute," in scientific circles, denotes both an even reduction, and intensity, of all pigments (the key being the retention of all colors and patterns, but in faded condition). As of this writing, the author has examined slides from Australia, and the U.S., and briefly viewed some individuals. It is the author's hope to be working with the birds directly, which is necessary in order to discover their true behavior. Presently, however, one cannot yet rule out the possibility of schizochroism.

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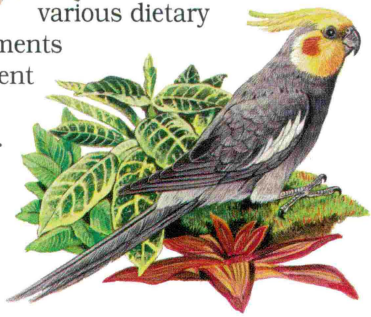

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