RANDOM THOUGHTS — On Genetics

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There simply is no way to get around the fact that genetics is a complex subject. That does not mean that it is too hard for most of us to learn, it just means that we need to go at it in a very methodical manner and that we should not try to swallow too much of it at once. The most basic rules are easy to understand and do not require any knowledge of biology or use of technical terms (see box, page 40).

Most of the ways in which we need to understand and apply the natural laws of inheritance, unfortunately, require knowledge of more than the simplest and most basic rules. In order for us to make use of genetics, whether at a simple or complex level, we have to be able to communicate with one another about it. If we are to communicate, we all have to use the same language and that means we have to use the words of that language properly. Keep in mind that genetics is, first, a science and that it becomes a tool for us (and can become a very valuable tool) only after we gain some understanding of the technical aspects of it. Every activity (skiing, baking, brain surgery, editing, etc.) involves using words that make no sense to someone outside that field; genetics is no different.

There are only a few "technical terms" that one needs to know and they happen to be very easy to understand. Much more confusion results from misusing some common words that have very specific meanings in genetics than results from misunderstanding technical phrases. Aviculturists that want to understand and use genetic concepts usually wish to apply them to visible characteristics such as color, pattern, feather texture, size, and the like. Those are genetic *characters* and the various ways they can appear are *expressions* of the character. In cockatiels, for example, "color" might be the name of a character and "normal gray" and "lutino" two expressions of that character. "Color intensity" could be the name given a different character, with some expressions being "dilute," "normal," and "dark." "Color distribution" is still another character in cockatiels, with two expressions being "normal" and "pied." Each character is controlled by a separate set of genes, and the *genes* of one character do not interact with or have any effect upon the genes of a different character. The expression of one character, however, often has a very major effect on the expression of another; that's why one can breed a pied dilute gray bird.

If there is one genetic concept that is most important for aviculturists to understand, it is that we are usually dealing with two or more separate and distinct characters, that the genes for one character are inherited independently of the genes for others, and that it is the expressions of the genes (but NOT the genes themselves) that combine and interact. That concept is the foundation of understanding genetics, and misunderstanding (or being unaware of) it is the basis for much or even most of the confusion and misinformation in avicultural articles about genetics.

A frequent contributor to these pages reported recently that by breeding two birds that were "double split" for certain colors he was able to produce nine variations of color, including a few albinos. As a single character cannot be double split, it was apparent that he was dealing with at least two characters. From the information given in the article, it appears that he may be dealing with one character for color, for which the expressions are normal green or lutino, and another character for pigment in which the expressions include normal and no yellow. If that is indeed true, the pink-eyed white birds are not "true albinos," as he believes, but are lutinos that cannot produce yellow pigment. This may seem like hair splitting, but it isn't. If the birds in question have no gene for albinism, they cannot transmit it to their offspring, but will pass on separate genes for lutino and no yellow. Additionally, the aviculturist can greatly increase his production of the white birds by breeding one to a bird that he probably would describe as lutino split blue, for half the babies from that cross will be white. Of course, he could expect to get 100% lutinos, and might lead one to the conclusion that lutino is dominant to "albino," resulting in undesired results from future crosses.

Two other concepts that frequently

are confused or misunderstood by avicultural writers are the dominant/recessive relationship between genes and sex-linked genes. The concept of separate and independent characters, discussed above, may help clarify the other two somewhat but a little more explanation seems in order.

When the genes for two different expressions of a character are present, one may suppress the expression of the other. The gene that does express itself is called *dominant* and the one that disappears, or recedes, is called *recessive.* The recessive gene is just as "good" as the dominant; recessiveness does not indicate weakness or physical inferiority. In situations where there are three or more possible expressions of the same character, in fact, a gene can be recessive to one and dominant to another. The dominant/recessive relationship always is very specific: a dominant or recessive gene always is dominant or recessive *to* another specific gene. No gene is just "dominant," like Attila the Hun or something, or recessive like Mr. Milquetoast. The relationship exists only between genes for different expressions of the *same* character, never between *different* characters.

Sex-linked characters are simply those whose genes are on the same chromosome involved in determination of the sex of the bird. As all the genes on any chromosome tend to move from parent to offspring together, those on the sex chromosome seem "linked" to the sex of the bird. Sex-linked genes are no different from any other genes. The dominant/recessive relationship exists in them just as in other genes, with one major difference: every female bird has a chromosome that is, for our purposes, empty; it contains no genes. In every other case, a baby bird receives two genes controlling the expression of a character, but females receive only one gene for each sex-linked character. That gene may be either dominant or recessive in the male (who has the usual two genes for each character), but there is nothing in the female for that gene to be recessive or dominant *to,* so it is expressed in the bird.

Lady Gouldian finches provide an excellent example of everything we have discussed so far. Head color in gouldians is a character with two expressions: red is dominant to black (or, black recessive to red, it means precisely the same thing), and head color is a sex-linked character. A male gouldian with genes for both red and black will have a red head because red is dominant, but he can transmit a gene for either red or black to each of his offspring. Whichever gene his daughters get is the color their heads will be, because all they got from their mother was that "empty" chromosome that makes them females. Even if the daughters get the recessive black, there is nothing for it to be recessive to so it will be expressed. Half of the male babies will get a gene for red and half will get black from the father, but all the males will get a gene from their mother for whatever color her head is. If that is black, then half the male babies will have black heads (because they have black genes from both parents and therefore have no gene for red) and the others will have red heads (because they got a gene for red from their father and red is dominant to black). If the mother's head is red, all the male babies will get a gene for red from her and, because red is dominant to black, all will have red heads. BUT, you may ask, what happened to yellow headed gouldians? Glad you asked, for that is part of what makes gouldians such a good example of all this!

The rather unpleasant mustard color

that sometimes appears on gouldians' heads, often enthusiastically called yellow, is not an expression of the character "head color," as are red and black. Yellow is an expression of a different character (which is even on a different chromosome than head color, incidentally) that we might call red pigment. The expressions of red pigment are normal and yellow (in which red is changed to that mustard tone). A yellow headed gouldian, therefore, genetically is sort of a modified red head. As yellow head is not an expression of head color, there can be no dominant/recessive relationship between yellow and either red or black head.

Genetics is a science and geneticists use a lot of technical "scientific" terms. The reason they use them is that such terms are very precise and because they always mean the same thing. Aviculturists should use at least a few of those terms for the very same reason and because it is a lot easier to use one precise word than two or three sentences. *Homozygous* and *heterozygous* are good examples. When an individual is said to be homozygous for a character, it just means that the individual has two genes for the same expression of that character. An heterozygous individual has genes for two different expressions of the character. It is easy to remember which is which, because we all know, nowadays, that the prefix "homo-" means two that are the same and that "hetero-" means two that are different. The male gouldian with genes for both red and black head was heterozygous. If he had had two genes for red, he would have been an homozygous dominant; if two genes for black, an homozygous recessive.

One occasionally encounters the term *"multiple alleles."* All that means is that there are more than two possible expressions of a character; it is a very common condition. If a bird's color can be expressed as black, brown, blue, yellow, purple, and puce (or any other colors) and we *know* that only one character is involved, then it is a case of multiple alleles. Knowing whether one is dealing with multiple alleles can be very important, crucial in some instances, in deciphering a bird's genetic make-up and in planning a breeding program with specific objectives in mind. In the case of some characters, such as the degree of piedness in some species, there may well be dozens of alleles for a single character.

The one remaining area where we often seem to work against our own best interests is in *not* using the geneticists' shorthand system of recording and diagramming genetic relationship. The system works like a charm, is easy to learn, and provides more information at a glance than any other so far invented. Using the system will make your own genetic detective work and record keeping easier and, just as important, will make it easier to share information with others.

The system is simply a code that you make up, using upper case (A, B, C, etc.) letters for dominant genes and lower case (a, b, c, etc.) for recessives. Traditionally, one uses the first letter of the word describing the dominant gene to represent all the genes for that same character. In gouldians, for example, one could use R for the gene for red head (the dominant gene), in which case r would represent black (the recessive). Because the whole system is a code, it makes absolutely no difference what letters one uses; "A" for the dominant and "a" for the recessive would be just as appropriate as "R" and "r" in the example. Do not, as many avicultural writers have, decide that it makes more sense to use the initial of each gene, as in "R" for red, "b" for black, etc. It can quickly lead to mass confusion. Keep in mind that it's a *code* for, not a description of, the genes and that it is *your* code; someone else may write it differently.

Because you may wish to share information with another aviculturist and because you may not recall the code a few years from now, write it down. Before you can write down information, of course, you have to have that information, and obtaining good information is the hardest part of all of this. You can get it from the meticulous records you have kept of various crosses and the results, from someone else that keeps careful records of the species in which you're interested, or you can try to glean it from books and magazines. The last option (books and magazines) is unquestionably the absolute worst source. In any event, if you have or can get lots of data about the species in which you're interested, make a written record of the genetic code you devise.

Using gouldians again, because the genetics are well known, and including the red pigment character to make it more interesting, you might assemble a code as follows (Comments in parentheses are explanations, not part of the code.): A = red (dominant), a = black (recessive), B = normal red pigment (dominant, and this is the second character), b = red changed to yellow (recessive). Head color (A and a) is sex-linked, quality of red pigment (B and b) is not. A male gouldian that is heterozygous for both characters would be abbreviated as Aa Bb. A black headed female gouldian that is heterozygous for quality of red pigment could be *a Bb (the * represents the empty Y chromosome of the female; any symbol will do, but don't leave it out — you're going to need it). When this lovely pair of birds gets down to work punching out lots of babies for you, you can safely predict the following (genes derived from the male are in bold type so you can tell where they came from):

Parents

Aa Bb X *a Bb

Babies

Aa **B**B(1)	**a**a **B**B(2)	**A** * **B**B(1)	**a** * **B**B(2)
Aa **B**b(1)	**a**a **B**b(2)	**A** * **B**b(1)	**a** * B**b**(2)
Aa B**b**(1)	**a**a B**b**(2)	**A** * B**b**(1)	**a** * **B**b(2)
Aa b**b**(3)	**a**a b**b**(2)	**A** * b**b**(3)	**a** * b**b**(2)

Some of the combinations show up twice, but that is because they happen twice. This is a fairly simple and very common combination of genes, but there are 16 genetic combinations listed. Each one, and the parents', is called a *genotype;* word descriptions of how they look are *phenotypes.* The phenotypes for the above genotypes are indicated in parentheses and are listed below.

1. Any bird with an A and at least one B is red headed (because it has dominant genes for both red and normal pigment)
2. Any bird without an A, regardless of any B's or b's, is black headed (because it has no gene for red, and the pigment quality genes cannot change red if it isn't there)
3. Any bird with an A and without a B (has two b's) is a yellow head (red is changed to yellow by the recessive pigment quality genes)

Although there are 16 genotypes, therefore, there are only three phenotypes. If all you knew when this breeding started was that the male had a red head and the female black, you have learned that the male is heterozygous for both head color and pigment quality and the female heterozygous for pigment quality. You have learned that, of the babies with black or red heads, two thirds have a recessive gene for yellow. Those facts, and other information derived from the chart of genotypes, can be very helpful in selecting birds for future crosses. If you happen to breed Princess of Wales or

Indian Ringneck parakeets, both of which have numerous color variations involving two, three, or more characters, assembling and using charts like the above can be immensely useful.

Much of the preceding will be found to disagree with material published in other articles on genetics. That's because most of the published avicultural genetics articles contain a lot of misinformation. You may read of "different" or "additional" sex chromosomes in birds, the "W" and "O;" they are not different or additional and they function like the X and Y because they are the X and Y. W and O are just different labels for the same chromosomes. One of the reasons for the frequent use of Lady Gouldian finches as examples in this article is in the hope (probably forlorn) of undoing some of the damage done by an article on gouldian genetics, published in another magazine a few years ago, in which the author managed to get nearly everything wrong.

The concepts and terms in this article may seem strange and complex, but that is because they are unfamiliar. The words and techniques used in learning to ski, bake a cake, or perform brain surgery are difficult at first, too, and each of those is more complex than the genetics discussed above. Readers interested in more information (perhaps as a form of self abuse) are welcome to write (240 W. Center Street, Moab, UT 84532) for a more detailed, expanded version of the above. Other comments and questions also are most welcome.

Synopsis of greatly simplified basic genetics.

In non sex-linked inheritance:

1. Every individual has two genes for each character (a character is a specific physical feature such as color, pattern, feather type, etc.).

2. When eggs or sperm are produced, the two genes are separated and each egg or sperm receives only one gene for each character.

3. When an egg and sperm unite, each brings one gene for each character into the union and the resulting embryo thus has two genes of each character — one from the mother and one from the father.

In sex-linked inheritance:

1. As far as the male is concerned, the situation is exactly the same as in non sex-linked inheritance.

2. Females have only **one** gene for any sex-linked character. They always receive it from their father and pass it on only to their sons.

3. Because she can have only one gene for any sex-linked character, a hen can never exhibit one sex-linked trait and be "split" for another. A male, having two genes for every character, can be "split" for sex-linked characters just as readily as for non sex-linked.

In both sex-linked and non sex-linked inheritance:

1. Some genes "dominate" or cover up others. A dominated gene's effect recedes, or disappears, from view and the gene is called recessive. Recessive genes are just as strong, healthy, vigorous, etc. as dominant members of the pair; they are just masked by the dominant.

2. Dominant/recessive relationships can exist only between genes that control the same character. Because there is a lot of confusion as to what constitutes a character, however, a lot of misinformation about dominance and recessiveness gets published.

3. Genes change. We call the changes "mutations." Mutations are natural, normal, and very common, but most of them have only a minor effect on the host and we don't even notice them. Occasionally, mutations are dramatic: the black mutations of red in gouldian head color, lutino mutation of gray in cockatiels, pied mutation of solid color in many species, etc. There can be many mutations of the same character. Although most mutations are recessive to the wild type form, they can be dominant or can result in a mixing or blending of colors or other features.

4. There can be any number of gene mutations for any character, but an individual bird can have no more than two of those genes. If some imaginary species' wild type gray color had mutations of black, fawn, and lutino, for example, no one bird could possess the genes for more than two of the four alternatives.

5. Because the genes for one character act independently of those for others, one pair of genes can profoundly effect other pairs. In the preceding example, for instance, the imaginary species could have entirely different genes which control pigment production. If those genes dictated "no pigment," the bird would be an albino. The bird would still possess the genes for one or two of the colors, and could pass them onto its offspring, but the bird would be incapable of producing pigment. This condition, where one character effects the expression of another, is called epistasis and is *not* a form of the dominant/recessive relationship. ●

There is a Time for Learning and Fun

Join AFA in

TAMPA

and Get All in One

by Phyllis K. Martin
Tampa, Florida

The pet fancier delights in the unique one-to-one relationship he develops with his pet bird. The collector draws satisfaction from the variety and beauty of his living jewels. The scientist expands his intellectual horizons through study of his delicate subjects. The breeder devotes himself to the care and propagation of species of birds both common and rare.

All of these people — all of us — represent the many facets of aviculture. We are drawn together into specialty clubs and general interest clubs and societies through a common bond: *The desire to learn and the desire to protect our interest.*

Each year the American Federation of Aviculture hosts a five day convention to bring aviculturists together to further their knowledge in the latest avian breeding successes, accomplishments and developments in avian husbandry and veterinarian medicine. This year we will have ornithologists, researchers, zoo professionals, and private aviculturists speaking on a wide variety of topics. In the next issue of WATCHBIRD we will have a list of the confirmed speakers and the topic or subject of their lecture.

In conjunction with the convention program there will be an exhibit area open to the public and convention registrants from Thursday through Sunday. This unique market place offers the aviculturists the opportunity to see new products relating to bird keeping ranging from cage designs, feeds and seeds, medications and food supplements, publications and books covering all types of birds.

While in Tampa AFA will be offering several tours. One of the tours will be a visit to the new Tampa Lowry Zoo. The zoo exhibits a large walk through aviary with many species of birds for your viewing pleasure such as fire-tufted barbets, hammerkop, blue-crowned pigeon, black-necked stilts, Goldie's lorikeets, hanging parrots, Touracos, ducks, geese, ibis, teals, rails, pheasants, starlings, fig parrots, white-crested laughing thrushes and many more flying free. Off to the side of the walk-thru aviary there will be displays of large species of birds such as toco toucans and wreathed hornbills.

We will also be visiting Sea World's new *Penguin* exhibit and the many bird displays located at Busch Gardens.

So come join the fun. Bring your family and friends and enjoy Tampa's southern hospitality. ●

(continued next issue...)