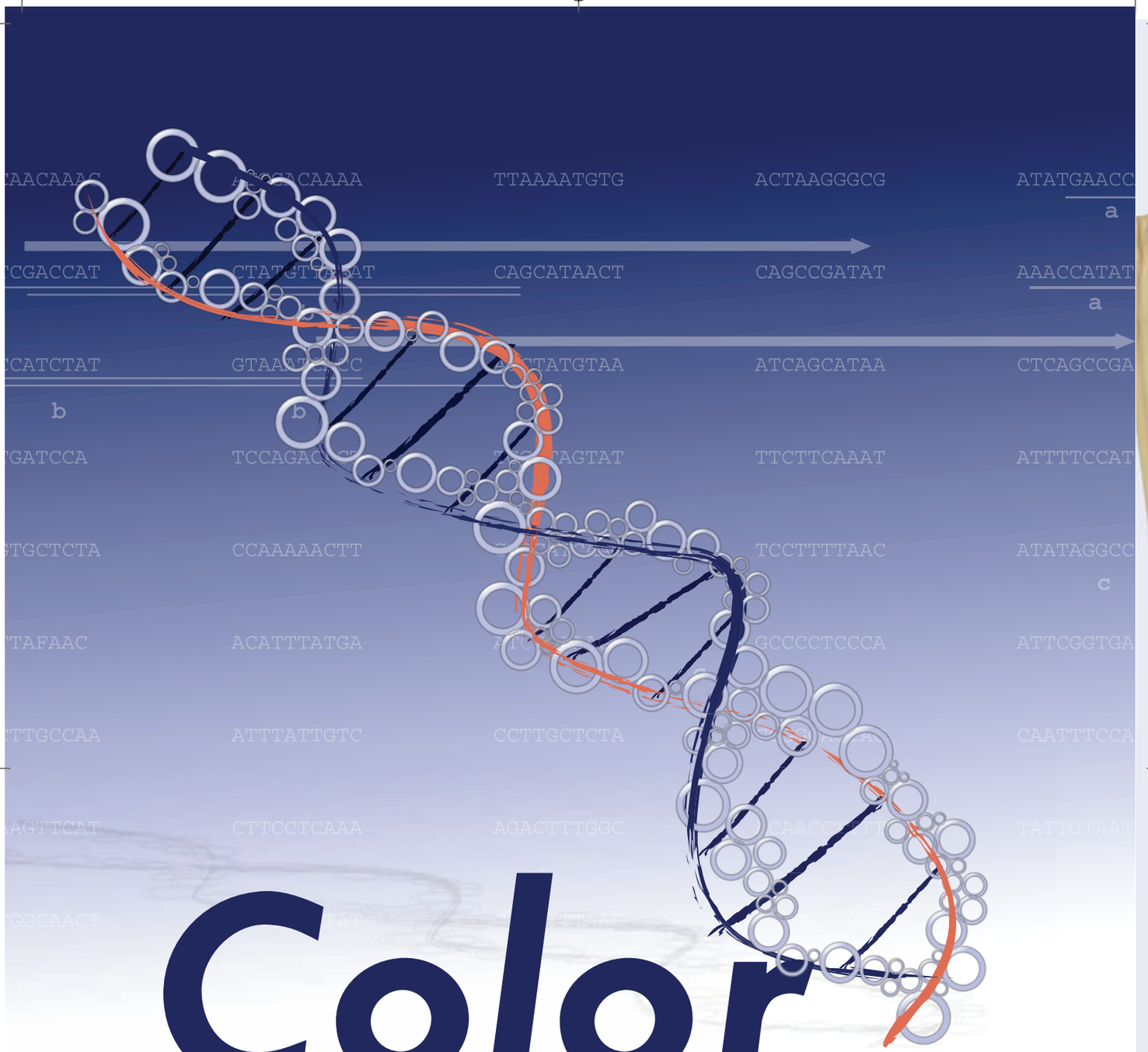

Color genetic myths

Practical findings on Appaloosa color genetics

By Robert Lapp and Gene Carr
Illustrated by Sean Murphy

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COLORFUL MYTHS

Photo A: Classic blanket with spots

This article initiates a series of monthly research reports focusing on Appaloosa color genetics, homozygosity, and coat pattern inheritance. As with our first report, Applied Appaloosa Color Genetics in the March 1998 *Appaloosa Journal*, our current approach is "applied" or practical, rather than theoretical.

Many of the "genetic rules" governing inheritance of Appaloosa color are unknown, speculative and undocumented, or the subject of ongoing research. Regardless of how much is still unknown, we believe we've found substantial and persuasive real-world evidence supporting the genetic claims we'll set forth. We base our findings on 40 years of breeding experience (Carr), communication with other breeders, and analysis of hundreds of pictures and production records (Lapp).

Throughout the series, we'll address the many dimensions of one overriding question: What's the relationship between an Appaloosa stallion or mare's coat pattern type or structure and the likelihood of producing colorful foals?

Part one of this series examines color genetic myths—beliefs about coat pattern types and color inheritance often regarded as factual but which are false or misleading.

Subsequent research reports will identify the defining characteristics of the four established homozygous Appaloosa patterns: few-spot, snowcap, fewcap and sky eyes. We then end the monthly series with a discussion of genetic issues: questions surrounding Appaloosa roans, the possibility of a fifth homozygous pattern, and a discussion of "genetic anomalies"—Appaloosas with coat patterns that don't seem to fit any of our categories, yet whose production and parentage indicate they are unquestionably homozygous.

Writing about Appaloosa genetics challenges us to make very complicated material as simple and clear as possible. We have endeavored to do so, but hope readers will appreciate how "simple and clear" do not always mean quickly and easily understood.

While we hope to advance the scientific understanding of Appaloosa color genetics and coat pattern inheritance, our fundamental intent is more practical—helping the Appaloosa breeder distinguish between fact and fiction in an effort to produce a colorful foal.

PART 1: COLOR GENETIC MYTHS

Increased discussion of Appaloosa genetics on the Internet has resulted in a proliferation of information, some of which is not only false and misleading, but which will produce breeding results contrary to what's expected. We call such genetic beliefs "myths"—for they're claims about coat pattern identification and color inheritance that range from misleading to fictitious.

For each of the myths that follow, we describe what's believed and then explain the myth's shortcomings.

Myth # 1: A stallion or mare is homozygous if it has 100 percent color production. **Analysis:** 100 percent color production is not necessarily an indicator of homozygosity. One must first consider parentage, then coat pattern type, the number of foals produced, and the kinds of matings involved.

Crossbred Appaloosas, by definition, are not homozygous. Although leopard Appaloosas or those with blanket/spots may have produced 10 colored foals, including several from Quarter Horse breedings, our research is conclusive: the basic leopard and blanket-with-spots patterns are heterozygous. Appaloosas with these patterns aren't genetically capable of producing 100 percent colored foals, and will not, once the number and types of breedings increase. (See Photo A: Classic blanket with spots)

Myth # 2: White-tipped ears are characteristic of the few-spot leopard and

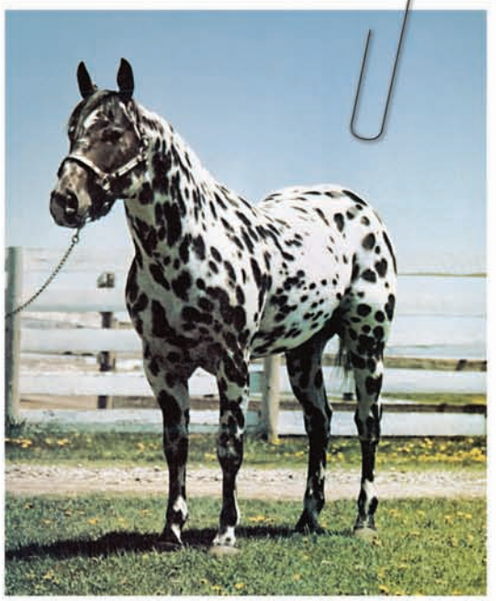

Photo B: Heavy leopard

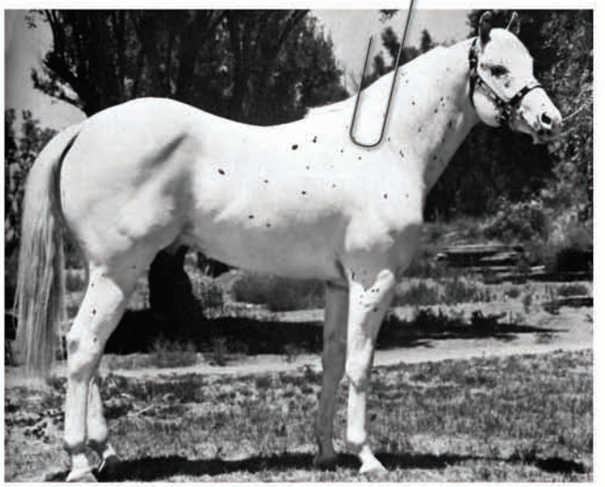

Photo C: Light leopard

snowcap patterns and therefore indicate homozygosity for producing colored foals.

Analysis: White-tipped ears can be found in conjunction with nearly every Appaloosa pattern type and aren't an indicator of homozygosity. Some few-spot and snowcaps have them; others don't. They aren't unique to any documented homozygous pattern and are found with heterozygous patterns as well. "White-tipped" can be easily confused with white on the ear. Placement of white is the key factor—the tip of the ear, roughly the top inch or two, is white with no spotting or roaning.

Since white-tipped ears are unrelated to both homozygosity and heterozygosity, their technical identification is fundamentally a moot point.

Myth # 3: The few-spot leopard pattern cannot be produced unless at least one parent is a leopard.

Analysis: Early research (Carr—1972) suggested this "myth" was probably true.

Our 1998 article amended that belief with the following statement: "While further pedigree research is being conducted at this writing, producing a few-spot appears to require at least one leopard parent in either the first or second generation."

As research since 1998 has demonstrated, "appearances" can be deceiving. We can now document few-spots whose leopard parentage doesn't appear until the third or fourth generation of the pedigree. While every few-spot we've identified does in fact have a leopard somewhere in its pedigree, we can't stipulate an exact generational requirement.

We suspect that genes producing the leopard complex of related patterns are entirely different from genes producing blankets, and may operate in ways that have yet to be documented. Such differences may account for producing some few-spots whose leopard parentage shows up much further back in the pedigree than what was determined from earlier research.

Myth # 4: The greater the number and size of spots on a stallion or mare, the greater the likelihood of producing a colored foal or higher color production, especially from crossbred stallions or mares.

Analysis: This belief is false. A larger number and size of spots don't correlate to higher color production or an increased probability for producing a colored foal. In fact, we find the inverse to be true: the smaller the number and size of spots, the greater the likelihood of producing color and higher color production, especially when crossbreeding. The leopard pattern provides some of the best evidence. For the lack of better terminology, we've identified "heavy leopard" and "light leopard" patterns (see photos B and C). Although research continues, we've found almost without exception that the light leopard pattern produces a higher color percentage than the heavy pattern, especially when crossbreeding is used.

This tendency doesn't appear to be confined to leopards, despite what we've suggested is their entirely different genetic make-up. It appears to include the classic "blanket with spots" as well.

Myth # 5: A stallion or mare can't be homozygous for producing color if one or both parents are themselves the product of crossbreeding. In other words, even if a stallion is Appaloosa x Appaloosa bred, he can't possibly be homozygous if one or both of his Appaloosa parents have been produced from a crossbreeding.

Analysis: This belief is absolutely false. Although producing homozygous Appaloosa patterns requires two Appaloosa parents, we've found many examples of few-spots and snowcaps whose sires or dams were the products of a crossbreeding.

Consider the few-spot Bright Early Nugget. His sire and dam were Appaloosas.

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Nugget Jim, his sire, was the product of an Appaloosa and Quarter Horse breeding.

Another example, the Hall of Fame snowcap stallion, is Absarokee Sunset. His sire, Flamingo Of AA, had a Thoroughbred dam. The homozygous Appaloosa patterns require two Appaloosa parents. Later, in Myth # 9, we'll explain what we include as "Appaloosa parents."

Myth # 6: The snowcap pattern involves a white blanket with very few spots or none at all.

Analysis: This myth is simplistic and easily misleading. Believing it can result in misidentification of the snowcap pattern—identifying a pattern as a snowcap when in fact it's what we've labeled a "false snowcap"—the pattern "seems like" a snowcap but isn't.

Misidentification occurs when a) the number, size, configuration and especially placement of spots, aren't evaluated carefully; or b) a white blanket with no spots is presumed to be a snowcap (see photos D, E and F). The consequences of misidentification can be tragic, epecially if a stallion is offered at stud to the public. If a "false snowcap" isn't detected and is represented as a 100 percent color-producer, some people will be more than disappointed.

Identifying the snowcap pattern isn't always as easy as one might think.

A legitimate snowcap may have roughly one to three or four spots lower down on the hip or several on the back but closer to the withers. If these spots are located midway or higher up the hip or in the white blanket at the top of the hip, the pattern isn't a snowcap.

Assessing spot size or their diameter isn't an exact science. If the size exceeds an approximate range of one to two or three inches (2.5–7.5 cm) in diameter, the horse is probably not a snowcap. Spot "configuration" is an altogether different issue. A later article in which we'll focus only on the snowcap pattern will explore what is or isn't a "spot" as opposed to what we call "splotches." All snowcaps have a white blanket. However, even when the blanket has no spots in it, misidentification is still possible, and we believe, more likely.

Some blankets aren't really "white"—they contain roan hairs scattered throughout the white. These Appaloosas are false snowcaps and are often the result of crossbreeding. They aren't homozygous. The "white" blanket requires very careful and preferably live examination. Absent the opportunity for a live and up-close look, only very clear pictures from a variety of angles will determine if the pattern is a legitimate snowcap (see photo G on page 46) or a false one. We've seen pictures of many Appaloosas that appear to be snowcaps but have a Quarter Horse sire or dam. In nearly every case, better pictures from different angles resolve the problem and show roan hairs throughout most of the blanket.

Photo D: False snowcap

Photo E: False snowcap

Photo F: False snowcap

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Photo G: Classic snowcap

How have we identified these characteristics of a false snowcap? By studying live animals, hundreds of pictures of potential snowcaps, and then correlating them with pedigree and production records. Sometimes however, especially when animals have no production record, the call can be a very close one.

Myth # 7: Producing a leopard or blanket pattern is best achieved by breeding leopard-to-leopard and blanket-to-blanket.
Analysis: This claim is misleading because it ignores the generational pattern-influencing genetics of the two parents' ancestors. Two leopard parents may have leopard and blanket patterns mixed together in previous generations. Likewise, two blanketed Appaloosas may have leopard patterns mixed with blankets. In both cases, the mixing of ancestral patterns prevents using simple phenotype (appearance) as a basis for breeding decisions. In short, selection for either a leopard or blanket pattern requires examination of at least three or four generations of ancestral coat patterns. Even then, however, the breeding match-up can be problematic because we lack the genetic knowledge for predicting how mixed patterns are inherited over even several generations. But there's another and more complicated problem: What is a "leopard"?

We regard leopard not as a pattern as such, but a complex or family of patterns in which the number, size and placement of spots will vary radically.

The variations can be so extreme that we're now attempting to organize the leopard pattern into distinct types or categories, each with their own defining characteristics. Our research is ongoing, but we suspect these variations produce very different overall color production percentages.

Myth # 8: Pattern labels such as near-few-spot, near-snowcap, and near-leopard can help determine the relationship between phenotype and genotype.
Analysis: Whether intended or not, use of these labels actually classifies coat patterns into groups or categories. Such labels represent more than mere words. At a minimum, they should be distinctive and provide clues about genotype that will help breeders make color-related breeding decisions. On the other hand, if these labels aren't intended to help predict the pheno-genotype relationship, then what's their value or function? What practical information do breeders gain?

This "myth" raises a host of questions and problems:

What do terms like "near-few-spot" tell us about both pheno- and genotype?

Is this Appaloosa "close to," "just about," or "kind of like" a few-spot but not quite?

Since few-spots are homozygous for producing color, does "near" imply "close to" being homozygous but not quite a 100 percent color-producer?

Does it necessarily suggest a greater likelihood of producing a colored foal and higher color production than would an Appaloosa who is *not* a "near" one and is heterozygous?

If a potential mating involves cross-breeding or non-characteristic Appaloosas, does "near-few-spot or snowcap" imply a greater chance of producing a colored versus non-characteristic foal than what we'd expect from a different heterozygous animal and pattern?

The few-spot pattern is capable of producing virtually all Appaloosa coat patterns. Does "near" mean the Appaloosa stallion or mare will produce some types of patterns but not others—and which ones?

Is the "near leopard" not quite a leopard but more likely to produce one when bred to a blanketed Appaloosa with no leopard in its pedigree, and especially if crossed out or bred to a non-characteristic Appaloosa?

If a "near-leopard" doesn't have a leopard in its pedigree, it's a "false leopard" and won't produce a leopard pattern without help. If it does have a leopard in its pedigree, it's capable of producing a leopard pattern on its own. Therefore, calling it a "near-leopard" serves no apparent useful purpose. (Note: As explained earlier, we're developing classifications for different kinds of leopard patterns. "Near" won't be one of them, and is a very poor choice of words.)

If "near-leopard" is troublesome, "leopard" itself is even more problematic. Genuine leopards express their pattern at birth and don't roan. However, we are now able to identify "false leopards"—Appaloosas that look like leopards by any definition but are not. How is this possible?

Field research proves the claim beyond doubt. We've either owned or acquired "before and after" pictures of Appaloosas, which at birth and up to about 2 years old, were either roans or displayed the classic blanket-with-spots pattern. These Appaloosas roaned out, leaving only spots on nearly head-to-tail white. Many people would think they were leopards. They aren't—and lacking a leopard in the pedigree, won't produce a leopard pattern without help.

No one has ever claimed, much less documented, that any of these "near"

types are homozygous. We've examined many records of patterns described as "near" and found what ought to be obvious: they're heterozygous, and with enough breedings, will produce a non-characteristic foal.

While we agree with efforts to standardize the terminology used to describe or categorize Appaloosa patterns, we believe using "near" confuses and misleads far more than it assists. Put more simply, the research data classifying "near few-spot," snowcap or leopard as independent and distinct categories doesn't exist. Use of these labels is unwarranted and should be discontinued in favor of language based on documenting differentiated and distinctive characteristics.

(Note: A future research report will introduce a new homozygous pattern—the "few-cap"—a pattern displaying characteristics of both few-spot leopards and snowcaps. While research is ongoing, we highly suspect some of the Appaloosas described as "near" few-spots or snowcaps are actually "few-caps," and some of the "near-snowcaps" are the false snowcaps described earlier.)

Myth # 9: A homozygous Appaloosa can only be produced from an Appaloosa-to-Appaloosa mating.

Analysis: Although the statement is basically true, it's also misleading because it doesn't take the non-characteristic Appaloosa into consideration.

Based on live observations, we can now document the following: few-spot and snowcap Appaloosas have in fact been produced from the mating of verified non-characteristic Appaloosas crossed to leopard Appaloosas or blanketed Appaloosas with a leopard in the pedigree.

In other words, a non-characteristic Appaloosa bred to a colored Appaloosa has produced a homozygous foal.

We know personally of at least six such breedings in which the evidence is definitive and we're now examining other reported possibilities. While we're not prepared to claim that any and all non-characteristic Appaloosas are capable of producing homozygous foals, the strength of our current evidence justifies the following:

- Homozygous foals can be produced from crossing a non-characteristic Appaloosa with a colored Appaloosa;
- Either one of the parents—stallion or mare—can be non-characteristic;
- Producing such a homozygous foal appears to be more probable if one of the parents is a leopard or has close-up leopard breeding—how close can't be stipulated at this point; and
- All non-characteristic Appaloosas aren't genetically the same; some appear to have greater color-producing potential than others.

Although unrelated to homozygosity, we can also document cases in which a non-characteristic mare with leopard breeding has produced a leopard foal when bred to a colored stallion with no leopards in his pedigree.

What we've documented is profound and must surely prompt a serious rethinking about the genetic make-up of non-characteristic Appaloosas.

Their phenotype or visual appearance may well be devoid of Appaloosa color or characteristics, but their color-producing genetic material appears to be an altogether different phenomenon. Furthermore, our examples lend credibility to our belief that the genes producing leopard patterns are different from, and operate differently than, whatever genes are involved in producing the classic blanket-with-spots pattern.

SUMMARY: COLOR GENETIC MYTHS

The Internet has facilitated an increased interest in the discussion of Appaloosa color genetics and coat pattern inheritance. We applaud such interest but are concerned by too many beliefs or claims of genetic facts that are simply untrue or are offered without credible evidence. We call such beliefs or claims "myths," and have identified at least nine that are common.

Although we've focused on color genetics, the goal we pursue is identical to how we concluded our 1998 article. We're not attempting to return to the days where too many breeders disregarded quality in favor of color. Nor are we content with what appear to be still-current efforts making color an add-on or secondary consideration. We believe breeders ought to, and with effort, have it both ways. Hopefully, our ongoing research and reports will increase the likelihood of doing so.

Bios:

Robert A. Lapp:

Bob has been involved with horses since the 1950s and joined the ApHC in 1984. He served two consecutive terms on the ApHC Board of Directors (1995–2001), during which time he started researching Appaloosa color genetics and presented seminars to the Board of Directors and ApHC membership. His research has continued since leaving the board in 2001. As a long-time student of Appaloosa history, Bob has been the author of *Appaloosa Journal's* Lapp's Apps Trivia Contest since 1994.

Gene Carr:

Gene joined the ApHC in 1962 and has been raising Appaloosas for more than 40 years. He was first elected to the ApHC Board of Directors in 1997 and continues as a current director, serving the ApHC in many different local, state, regional and national capacities. He's been researching and publishing articles about Appaloosa bloodlines and color genetics for more than 30 years and was instrumental in developing the first scientific DNA study of Appaloosa genetics at the Univeristy of Kentucky's Gluck Institute.

Gene and Bob started their genetic team-work research in 1997.