DIGITAL

Cornsnake Morph Guide

A Collector's, Breeder's, and Buyer's guide to Morphology, Genetics, Pricing, Identification

2005 Edition

Important Notice:

This book is the result of a lot of hard work. It took a lot of time and resources to research and gather existing knowledge, experiment and discover new knowledge, and finally to organize all of it into a useful format. If you wish to say thanks by leaving me a donation, you can send money via paypal to serpwidgets@hotmail.com, amazon (or other retail) gift card, or bitcoin using the QR code, or email me at serpwidgets@hotmail.com to see what other options might be available.

Thanks, and enjoy!
Charles Pritzel

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Table of Contents

Foreword

It is the author's hope that "psuedogenetics" can be done away with in the hobby and replaced with real genetics.

A vital part of understanding cornsnake morphs is genetics. It sounds more complicated than it is, especially when things are only explained in terms of "psuedogenetics." This method is intended to be a shortcut, but it ends up making everything seem extremely complex and nonsensical when in reality it is quite simple, logical, and with a little patience, easily understood.

"Psuedogenetics" only deals with simple recessive traits and nothing more. The cornsnake world has identified five genes out of twelve that do not fit that description. That is, almost half of cornsnake genes now defy the laws of psuedogenetics! As a result they are nonsense to many people, hobbyists and professionals alike. It is becoming less and less practical to use psuedogenetics to deal with cornsnake traits, and it will only get worse as more genes are discovered. Fortunately, these traits perfectly follow the simple workings of real genetics, so there is no need to be confused or lost.

If the genetics chapter of this book seems different than what is commonly taught in the hobby, or what you have learned from other hobbyists, it is because the way genetics is explained in this book is the way it really works.

This guide is intended to act as a starting point and a reference, as opposed to an all-encompassing knowledgebase. Once you have a grasp of genetics and a a feel for the various generic morphs, the best way to become familiar with the specific looks of the morphs and *all* their variations is to see as many examples of each of them as possible. Internet forums have a lot of pictures, and breeders' websites are another good resource. If you can attend reptile shows, browsing all of the tables and talking to the breeders is another good way to gain additional experience.

Since the "language" of the cornsnake hobby consists almost entirely of slang, you will undoubtedly hear differing usages of the terms in this guide. You'll also hear words that do not appear in this guide at all. The author will attempt to keep up with any common usages within the mainstream of the hobby, and a new edition will be published each year.

About the "Common Price Index" for morphs:

This guide includes a "price range" for each morph. The listed prices are included to give the reader a general idea of the current market prices of different morphs. They are calculated using a complex formula designed to determine a reasonable "ballpark" range. By no means are they a suggested price, nor are they necessarily the average.

Note that the prices are based on hatchlings. Lone females are often sold at 10% to 25% more than the cost of a single male because breeders find it more difficult to sell off remaining unpaired males.

Adults and juveniles are usually a lot more expensive than hatchlings, since they will be able to breed sooner. Proven breeders (snakes that have already produced offspring) are even more valuable.

All cornsnakes of the same morph are **not** created equal. Variations in price are based on factors such as:

- how common they are
- how difficult they are to produce
- how popular they are
- local availability
- the quality/distinctiveness of an individual breeder's bloodline(s) compared to other bloodlines of the same morph
- being het for additional genetic traits.

Many morphs can vary wildly in price, in some cases more than twice as much as others of the same morph. Trying to quote prices is like trying to predict the weather six months in advance, so take these numbers with a large grain of salt.

Finding the same morph for a lower price is not necessarily a better bargain… you tend to get what you pay for. Do not assume that any price above the listed range is overpriced. All cornsnakes are unique, and there may be a very good reason for the higher price tag.

Types of Morphs

There are three basic ways new morphs can come about:

- Genetic Traits
- Selective Breeding
- Hybridization/Intergradation

A ***genetic trait*** (more specifically "simple" genetic trait) results from a single, identified gene. If the genetic types of the parents are known, a simple set of rules can be applied to predict the ratios of offspring with these traits. An advantage of genetic traits is that they can be outcrossed (bred to unrelated individuals) and easily recovered in the grandchildren.

If you plan on breeding your cornsnakes, it's a good idea to understand how the rules of inheritance work, what "het" means, how offspring are labeled, and how having hets can affect the outcomes of your breedings. The Genetics chapter and online tutorial (http://cornguide.com) are made for that purpose.

Selective breeding (or *line breeding*) is a long-term program and works more like mixing paints together, where a breeder selects offspring that are closest to the desired appearance. For example, you could take the offspring from a clutch and choose those with the longest saddles, and breed them to each other. Keep doing this for several generations, and each time the saddles will get longer and longer. This happens because there are a lot of genes affecting this outcome. With each new generation, you are selecting those with more of the desireable genes and less of the undesireable genes than the previous generation. Outcrossing (breeding to unrelated lines) will generally create offspring who have an intermediate appearance and show varying degrees of the "desired" influence.

This is an important difference from simple genetic traits. When outcrossing a simple genetic trait, you only lose one gene, and need to recover a single "gene pair" in order to recover the trait. This is like flipping two coins and trying to get two of them to land on heads, which is a simple matter when you get 10 or more tries… an average clutch size for cornsnakes.

With selectively bred morphs, outcrossed offspring will have lost about half of the *many* genes affecting the appearance. In order to recover the

original appearance, it is necessary to gather *all* of these genes together again. This is like flipping a lot of coins, and trying to get *all* of them to land on heads. As a result, these looks cannot be recovered so easily after outcrossing.

Selectively bred looks are not the result of any known genes, and their inheritance cannot be accurately predicted. Although a lot of cornsnakes are labeled as "het" for many of these looks, they cannot be properly considered "het" for any selectively bred morph because there is no assurance that they will breed true with any other cornsnake of the same morph.

That is, when unrelated similar-looking individuals are bred together, the offspring may or may not show the desired "look" that their parents do. Keep this in mind when working with selectively bred morphs.

Hybridization/Intergradation is the process of breeding to another species or subspecies. Often these offspring are at least partially fertile, or in the case of intergrades, fully fertile, and can produce offspring. Some examples of this have become commonly accepted as "morphs."

Additional morphs can be produced through combining these methods:

- Selectively breeding individuals all having the same genetic trait has produced several new and distinctive morphs. (Candycane, sunglow, etc.)
- Multiple genetic traits can be bred into the same cornsnake. Generally, both traits are expressed at the same time, producing something that looks different than both of the "founding" morphs. Currently, the majority of cornsnake morphs are a result of combining genetic traits. (Snow, caramel motley, etc.)
- Selective breeding can be applied to a "genetic combination morph" to exaggerate certain characteristics. (Pink and green snow, etc.)
- In the most extreme example so far, selective breeding of intergrades exhibiting a genetic trait has produced at least one new morph: a "sunglow" variation of the "creamsicle."

Genetics

Many cornsnake morphs are based on genetic traits. This chapter is meant to familiarize the reader with the way these morphs come about, how they are reproduced, and a few important terms used to describe them.

For a more in-depth genetics primer, the author has an online genetics tutorial and additional practice problems/answers located at: http://cornguide.com

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Introduction:

Don't panic. Genetics seems intimidating at first, but don't forget that counting to a hundred seemed impossible before you learned how to do it. The people who could do it seemed way smarter than you at the time. But then you learned the names and symbols of 0 through 9, a few rules, and practiced a bit. It was frustrating, and sometimes you were convinced you'd never get it. But then, suddenly, it all fell into place and you could count to a million any time you wanted to! The same applies to genetics: a few definitions, a few rules, a bit of practice, and before you know it you'll be comfortable enough to tackle even the biggest genetics problems on your own.

People who can solve genetics problems are not geniuses, they’re just practiced. If you can count to a hundred, you too can learn genetics, as long as you're willing to keep going through some frustrating times, and practice practice practice.

Step 1: The building blocks.

The genetic code of a cornsnake is made of a string of genes, like the above string of symbols. Each symbol represents one gene. Here we only show a handful, but in real life, cornsnakes have tens of thousands of genes. Below are some different genetic codes of cornsnakes.

Snake 1: ▲□✻●♥♤♦▬

Snake 2: △■✻●♥♠◇▬

Snake 3: ▲■✻○♡♠♦▬

Snake 4: △■✻●♥♠♦▭

What cornsnakes have in common is that the order of their genes is the same. Each place in the order is called a *locus*. In our example, we have the Triangle locus, followed by the Square locus, then the Star locus, the Circle, Heart, etc.

Why are all corns similar but not exactly the same? Notice that the loci stay the same but the genes vary from snake to snake.

Each locus holds a gene. Each gene has its own function in the cornsnake. For example, say the Circle locus is where you find the gene that produces black pigment.

(circle locus)
⇓
▲■✻●♥♠♦▬

As you know, not all cornsnakes have black pigment. The reason is that some of them have a defective copy of the gene normally found at the Circle locus.

(circle locus)
⇓
▲■✻○♥♠♦▬

Any different genes that can be found at the same locus are called *alleles.* (Allele is pronounced "***uh***-*leel*.") The allele most commonly found at a locus is called normal or **wild-type**.

● This is the *normal* or *wild-type* allele for the Circle locus.

○ This is a mutant allele for the Circle locus.

⊕ This is another mutant allele for the Circle locus.

◆ This is the *normal* or *wild-type* allele for the Diamond locus.

◇ This is a mutant allele for the Diamond locus.

There can be any number of alleles for a given locus. In this case, the Circle locus has three, and the Diamond locus has two.

Review:

- Corns are the same in that they have the same loci.
- Alleles are the different genes found at the same locus.
- There can be many different alleles for the same locus.
- Corns are not identical because they carry different alleles at their various loci.

Step 2: Putting the building blocks together.

Each cornsnake has two parents. It gets one full genetic code from each of its parents. This means that every cornsnake has **two** complete genetic codes. That is, each cornsnake has a pair of genes at each locus.

From mother: △■✻⊕♡♠◇▬

From father: ▲■✻○♡♠◆▬

Since the parents don't always have the same alleles, the cornsnake can have different alleles paired together. When the pair is identical, it is called homozygous, which is often shortened to "homo." The above cornsnake is homozygous at the Square, Star, Heart, Spade, and Rectangle loci.

■■ ✻✻ ♡♡ ♠♠ ▬▬

When the pair is different, the snake is said to be heterozygous, or *het*, at that locus. The snake is het at the Triangle, Circle, and Diamond loci.

△▲ ⊕○ ◇◆

Here are some more examples:

● ●	Homozygous	♦ ♦
⊕ ⊕		◇ ◇
○ ○		♡ ♡

⊕ ●	Heterozygous	△ ▲
⊕ ○		♠ ♤
● ○		♡ ♥

Review:

- Cornsnakes have two complete copies of the genetic code.
- At each locus, the copies can be the same or different.
- If they are the same, that locus is homozygous.
- If they are different, that locus is heterozygous.

Step 3: The results.

As you just learned, there can be two different alleles paired at the same locus. When that happens, which one controls the appearance of the snake?

This depends on the relationship of the two alleles. Any allele pair is either dominant/recessive, or codominant/codominant.

- In a dominant/recessive relationship, only the dominant allele is expressed. The recessive allele has no effect.
- In a codominant/codominant relationship, both alleles will have some effect. Sometimes one allele will have more effect than the other. Sometimes their effects are equal.

For example, let's look again at the Circle locus. There are three alleles:

●	The "Normal" allele produces lots of black pigment.
○	The "Albino" allele produces **no** black pigment.
⊕	The "Semi" allele produces some black pigment, but not much.

With these three alleles, a snake can have any of the following pairs:

Gene pair	***Appearance***	
● ●	Normal	*The normal allele can produce enough for the whole snake by itself. Anything carrying even one copy looks normal.*
● ⊕	Normal	
● ○	Normal	
⊕ ⊕	Reduced black pigment (hypo)	
⊕ ○	Very reduced black pigment (super hypo)	
○ ○	No black pigment (albino)	

Notice that ● is dominant to ⊕ and ○. This is true because when ● is present, the other two genes have no effect, the snake is normal.

Also notice that ⊕ is codominant with ○ because ⊕○ takes on an appearance between that of ○○ and ⊕⊕.

An *autosomal* trait is any trait whose appearance is controlled at one locus. The traits above, controlled by the Circle locus, are autosomal traits. Most cornsnake color and pattern traits are autosomal.

Review:

- Dominant and Codominant alleles are expressed when present.
- Recessive alleles are not expressed unless they are homozygous.
- An autosomal trait's appearance is controlled by the gene(s) at one locus.

Practice:

1-If △ (triangle) is recessive to ▲ (normal) then what do the following snakes look like?

A △▲	B ▲▲	C △△

2- If □ (square) is dominant to ■ (normal) then what do the following snakes look like?

A □■	B □□	C ■■

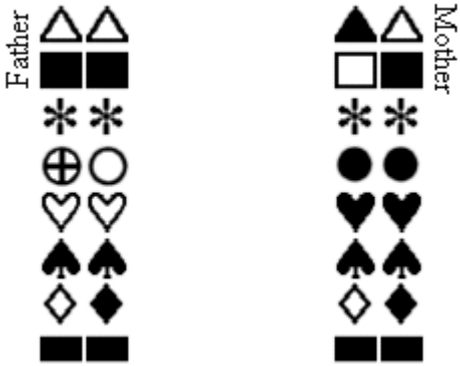
3- If ◇(diamond) and ◆(normal) are codominant, what do the following snakes look like?

A ◇ ◇	B ◆ ◆	C ◇ ◆

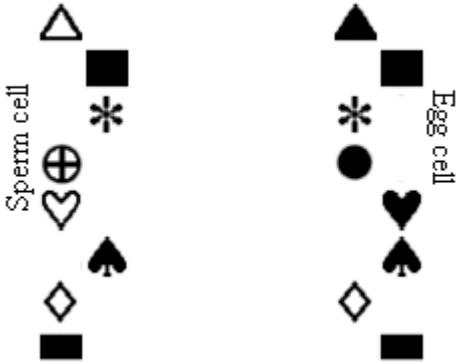
Step 4: Inheritance.

Now that you know how and why different genes can affect a cornsnake's appearance, the next step is to understand how an individual cornsnake inherits whichever genes it has.

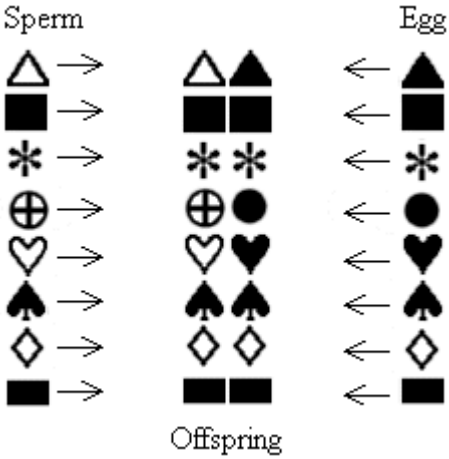
A cornsnake inherits one complete set of genes from each of its parents:



Half of the father's genes are put into each sperm cell. Half of the mother's genes are put into each egg cell. As shown below, each gene may come from either strand.



The sperm cell and egg cell combine to form the new fertilized egg with two complete sets of genes. This egg, known as a zygote, eventually grows to become an offspring. (*Zygote* is part of the terms *homozygous* and *heterozygous*.)



Review:

- Each sperm carries half of the father's genes.
- Each egg carries half of the mother's genes.
- The zygote (fertilized egg) has half of the father's and half of the mother's genes.
- The zygote has two copies of each gene, just like every other cornsnake.

Step 5: Predicting offspring.

To simplify things, let's look at only one locus. At a single locus, the sperm/egg can combine in one of four ways. As you'll see, you can use FOIL to remember the four ways. That is:

the **F**irst gene from each parent,
the **O**utside pair,
the **I**nside pair, and
the **L**ast gene from each parent.

It really is that simple. Let's practice. We'll use the Circle locus again, where ● is dominant to ○ and ⊕, and ○⊕ are codominant to each other.

Father ● ●	○ ○ Mother	
First ●	○	offspring is ➔ ● ○
Outside ●	○	offspring is ➔ ● ○
Inside ●	○	offspring is ➔ ● ○
Last ●	○	offspring is ➔ ● ○

Notice that all offspring are the same. When both parents are homozygous, all of the offspring are the same as each other. When both parents are homozygous for different alleles, like above, all of the offspring are het. These are “known hets” or “100% hets” or just plain “het.”

Father ● ●	● ○ Mother	
First ●	●	offspring is ➔ ● ●
Outside ●	○	offspring is ➔ ● ○
Inside ●	●	offspring is ➔ ● ●
Last ●	○	offspring is ➔ ● ○

Notice that half of the offspring are het and the other half are not. Since they all look like normals, it is not possible to tell which are the hets. Therefore, all of the offspring are considered “50% possible het” because each has a 50/50 chance of being het. Breeding trials can later prove which are het and not het.

Father ●○		●○ Mother	
First	●	●	offspring is ➔ ●●
Outside	●	○	offspring is ➔ ●○
Inside	○	●	offspring is ➔ ○●
Last	○	○	offspring is ➔ ○○

Notice that 1/4th of the offspring (the ○○ offspring) express the recessive trait. The other three: ●● and ●○ and ○● all look normal. Since two thirds (66%) of these normals are het, they are all considered "66% possible het" or "66% het" because each has a 66.67% chance of being het.

Father ●○		○⊕ Mother	
First	●	○	offspring is ➔ ●○
Outside	●	⊕	offspring is ➔ ●⊕
Inside	○	○	offspring is ➔ ○○
Last	○	⊕	offspring is ➔ ○⊕

Notice that the normal offspring (the top two) are het for the recessive ○ or ⊕ allele, but we cannot tell which offspring carries which recessive allele. There is currently no labeling standard for this scenario. If the recessive alleles are called "circle" and "cross," a good way to label these would be "het for circle ***or*** cross."

Review:

- When the genes of the parents at any locus are known, FOIL can be used to find all possible offspring.
- When only one parent is het for a recessive trait, and the other parent is homozygous normal, the offspring are all "50% possible het" for that trait.
- When both parents are het for a recessive trait, the normal offspring are all "66% possible het" for that trait.
- Possible hets are actually either het or not het. This can be proven through breeding trials.

Step 6: Combining traits.

When more than one locus is involved, FOIL can determine each trait individually, and then a grid can be used to determine the combined results. (This technique is similar to Punnett squares, but these are not Punnett squares.)

For this example, we will combine the recessive Triangle trait with the recessive Heart trait to show how a "Triangle + Heart" snake can be created, and to show how the results of the crosses can be calculated.

Start by crossing a snake with the Triangle trait to a snake with the Heart trait:

△△♥♥ X ▲▲♡♡

First, cross the Triangle locus. Use FOIL to get the results:

△△ x ▲▲ (there's only one result) → △▲

Then use FOIL on the Heart locus:

♥♥ x ♡♡ (there's only one result) → ♥♡

Now combine the Triangle results and the Heart results. Since there's only one result each time, there's only one type of offspring:

△▲♥♡

These offspring are het at the Triangle locus and the Heart locus. Since they are het at two loci, these snakes are "double het." Now, cross two of these double hets together to make a second generation:

First, cross the Triangle locus. Use FOIL to get the results.

△▲ x △▲

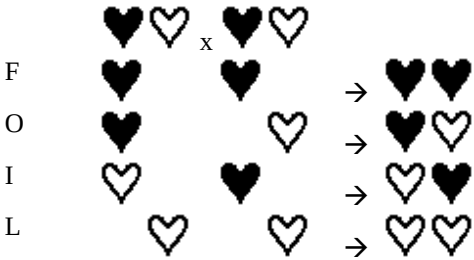
F △ △ → △△

O △ ▲ → △▲

I ▲ △ → ▲△

L ▲ ▲ → ▲▲

Then use FOIL on the Heart locus.



Now create a grid with the Triangle results going across and the Heart results going down:

	△△	△▲	▲△	▲▲
♥♥				
♥♡				
♡♥				
♡♡				

Then fill in the grid by copying triangles down from the top, and hearts across from the left:

	△△	△▲	▲△	▲▲
♥♥	△△ ♥♥	△▲ ♥♥	▲△ ♥♥	▲▲ ♥♥
♥♡	△△ ♥♡	△▲ ♥♡	▲△ ♥♡	▲▲ ♥♡
♡♥	△△ ♡♥	△▲ ♡♥	▲△ ♡♥	▲▲ ♡♥
♡♡	△△ ♡♡	△▲ ♡♡	▲△ ♡♡	▲▲ ♡♡

Notice that there are 16 possibilities. One of the sixteen (lower left) is homozygous for both recessive traits. The grid above shows how likely each type of offspring is. As with flipping coins or rolling dice, they are only odds… in real clutches, the numbers of each type will vary from the predictions.

Review:

- Use FOIL independently on each trait.
- Combine results for each trait by using a grid.
- Predictions are only the odds of what will happen. Actual results will vary.

Step 7: Using Notation.

Drawing and coloring complicated shapes can become a lot of work. Another way to do this is to represent the alleles by using letters instead of pictures. For example, the Heart locus has H instead of ♥ and h instead of ♡. The Triangle locus has T and t instead of ▲ and △. Customarily, the capital letters are used to represent the dominant alleles.

In this notation, the previous cross of double hets looks like this:
tTHh x **tTHh**.

At the T locus, use FOIL to get: tt, tT, Tt, tt
At the H locus, use FOIL to get: HH, Hh, hH, hh

Create the grid and fill it in, just like before:

	tt	tT	Tt	TT
HH	tt HH	tT HH	Tt HH	TT HH
Hh	tt Hh	tT Hh	Tt Hh	TT Hh
hH	tt hH	tT hH	Tt hH	TT hH
hh	tt hh	tT hh	Tt hh	TT hh

Review:

- Use letters to represent the alleles.
- Generally, the capital letter is used for the dominant allele.

Step 8: Combining Additional Loci.

If you are working with more than two loci, results for a third locus can be added in with the same grid method. Like before, take the first set of results and, using the grid, add the second set to it.

Let's use results for the D locus where the cross is Dd X dd. We will add these to the previous cross. (The original cross would then become tTHh**Dd** x tTHh**dd**.)

We already have the first two traits figured out. They are the 16 answer squares above.

Next, FOIL the results for the D locus:

```
  Dd X dd
F = Dd
O = Dd
I = dd
L = dd
```

Then use the D locus results going across, and each of the previous 16 (T and H) results going down. Notice that the D locus results can be simplified by removing the duplicate results.

	Dd	**dd**
TT HH	TT HH Dd	TT HH dd
Tt HH	Tt HH Dd	Tt HH dd
tT HH	tT HH Dd	tT HH dd
tt HH	tt HH Dd	tt HH dd
TT Hh	TT Hh Dd	TT Hh dd
Tt Hh	Tt Hh Dd	Tt Hh dd
tT Hh	tT Hh Dd	tT Hh dd
tt Hh	tt Hh Dd	tt Hh dd
TT hH	TT hH Dd	TT hH dd
Tt hH	Tt hH Dd	Tt hH dd
tT hH	tT hH Dd	tT hH dd
tt hH	tt hH Dd	tt hH dd
TT hh	TT hh Dd	TT hh dd
Tt hh	Tt hh Dd	Tt hh dd
tT hh	tT hh Dd	tT hh dd
tt hh	tt hh Dd	tt hh dd

This method is very easy to do once you've become comfortable with it. Its major drawback is that it can be time consuming when calculating the results of crosses involving 3 or more traits.

Review:

- A snake het at two loci is double het. Likewise, a snake het at three loci is triple het.
- Use FOIL independently for each locus.
- Combine results by creating a grid, with one set of results going across, the next set going down.

Step 9: A Shortcut.

An additional shortcut can be used if you are only interested in determining the chances of one or two outcomes. By using FOIL for each locus, you can determine the odds of the desired outcome *for that locus*. The odds at a single locus will always be 0, ¼, ½, ¾, or 1. Multiply the odds at all loci to get the total odds of that outcome.

For example, with the above cross **tTHhDd x tTHhdd** usually the main question is "what are the odds of getting **tt hh dd** offspring?"

FOIL the "t" locus to get tt, tT, Tt, TT.
Out of the 4 outcomes, 1 is "tt." Your odds are 1/4 so far.

FOIL the "h" locus to get HH, Hh, hH, hh.
Out of the 4 outcomes, 1 is "hh." Your odds are $1/4^{th}$ (from before) times $1/4^{th}$ (from this locus) for a total of $1/16^{th}$.

FOIL the "d" locus to get Dd, Dd, dd, dd.
Of the 4 outcomes, 2 are "dd." Multiply again:
$1/16^{th}$ times $2/4^{ths} = 2/64^{ths}$ which simplifies to 1/32.

The odds of getting **tt hh dd** from that cross are 1 in 32 for each offspring. If you count the squares in the grid created earlier, you'll find the same answer: there are 32 squares, only one of them is **tt hh dd**. This technique is a real time saver, and with a bit of practice, you can do it in your head.

There are also online genetics calculators that will give you the results, but it's helpful to understand where these results come from before using the calculator. It can also be handy to have a general idea of the expected results without having to run to the computer.

Review:

- Use FOIL independently for each locus.
- Determine how many of the four results at that locus are the ones you want. This is the "answer" for that locus.
- Multiply the answers for all loci together to get one fraction.
- This is the chance *for each egg* to hatch the desired type.
- Remember, these are only odds, and actual clutches will vary. Having 4 eggs with a 1 in 4 chance of hatching the desired type is by no means a sure thing.

Step 10: Practice.

Nobody has genetics mastered in the first run through. When you learned something new in school, you had to practice. Likewise, it takes some practice to become comfortable with approaching these problems. Following are some examples that can be used for practice. An answer key is provided in the back of this book. More examples/answers are available at http://cornguide.com.

Beginner:	**Intermediate:**
(*Hint: use FOIL*)	(*Hint: use FOIL on each trait individually, then combine them using a grid.*)
1- Cross aa X AA.	5- Cross aaBB X AAbb.
2- Cross Aa X aa.	6- Cross Aabb X aaBb.
3- Cross AA X Aa.	7- Cross aaBb X AaBb.
4- Cross Aa X Aa.	8- Cross AaBb X AaBb

Advanced:
(*Hint: use FOIL on each trait, then add in each new trait's results by using a grid.*)
9- Cross AABBcc X aabbCC.
10- Cross Aabbcc X aaBbcc.
11- Cross AaBbCC X aabbCc.
12- Cross AaBbCc X AaBbCc.

With practice, you will find that there are only six basic crosses, and FOIL isn't needed any more once these have been memorized.

Expert: *(Use the shortcut in Step 9.)*
13- When crossing AaBbCcDd X AabbccDd, what are the odds of getting the genotype aa bb cc dd?
14- When crossing aabbccdd X AaBbCcDd, what are the odds of getting aa bb cc dd?
15- When crossing AaBbCcDd X AaBbCcDd, what are the odds of getting aa bb cc dd?
16a- When crossing AaBbCcDd X AaBbCcDd, what are the odds of getting anything expressing the recessive a and b traits? 16b- What are the odds of getting anything expressing recessive traits b and c, but **not** expressing recessive traits a and d?

More practice problems/answers are available in the genetics section at http://cornguide.com.

Advanced topics:
Other topics that may someday apply to cornsnake genetics are trait linkage and sex-linked traits. So far, neither of these have been positively identified in cornsnakes. At some point in the future they will, and a discussion of these concepts may prove useful in an effort to identify such traits by their “odd” behavior.

Chromosomes and linkage.

Chromosomes are large groups of genes that are physically connected to each other. Because of this, genes that are on the same chromsome will often stay together. This is called linkage. The consequence of this is that linked traits will not “sort independently.”

Independent sorting is like flipping two coins: the way one coin lands has no effect on what the other coin does. They are independent of each other. A very strong linkage is similar to taping two coins to each other. Now when you flip the two coins, the two results will show a relationship to each other, either always the same or always the opposite.

The amount of linkage can vary. With a strong linkage, the two loci will almost always be inherited together from the same parent. This can have the effect of making it virtually impossible to combine two recessive traits into the same individual, or virtually impossible to separate two traits that are inherited from the same parent.

For example, let’s see what would happen if the Amel and Anery loci were linked. Let’s pick a number and say they inherit together 90% of the time. We’ll use the symbols:
“A” for the normal allele on the Amel locus,
“a” for the amel allele,
“E” for the normal allele on the Anery locus,
“e” for the anery allele.

Start with an Amel corn and an Anery corn. These would be “aaEE” and “AAee.” When these two are crossed together, each offspring would inherit “aE” from the Amel parent, and “Ae” from the Anery parent.

When you cross these double hets, keep the amel locus and the anery locus together. That is, 90% of the time, the offspring will inherit either “aE” or “Ae.” The two traits together will almost inherit like a single trait. The results are shown in figure 1.

	Ae	aE
Ae	AAee	AaEe
aE	AaEe	aaEE

Figure 1 – Linked double hets where "Ae aE" is crossed to "Ae aE"

The other 10% of the time, the a-locus and e-locus will "cross over." When this happens, an offspring can inherit either "AE" or "ae."

In order to be a "snow" (the expression of both traits: anery and amel) an offspring must be "aaee." For this to happen, it must inherit "ae" from one parent, and "ae" from the other parent.

To illustrate all possible outcomes, the above grid is multiplied by ten. One of the ten copies represents the 10% chance of crossover in each parent. The crossovers create the "AE" and "ae" pairs for each parent.

Figure 2 – Results of crossing with 90% linkage between two traits.

Notice that because of the linkage, "ae" will only appear 1 in 10 times. But when a crossover occurs, the opposite pair of "AE" is just as likely to be inherited from that parent. In all, there is only a 1 in 20 chance of inheriting "ae" from each parent, as shown on the bottom and on the right of figure 2. In order to be "aaee" (snow) this "ae" combo must be inherited from *both* parents. Together, the odds of that are 1/20 times 1/20, or a tiny 1 in 400 chance, as shown by the one square on the bottom right of figure 2. This is quite a difference from the typical 1 in 16 chance that occurs when traits sort independently.

Linkage not only keeps traits apart, it can also keep traits together. If you start with a snow ("aaee") and cross it to a normal ("AAEE") the offspring will inherit "ae" and "AE" instead. Notice that the mutant alleles are stuck together this time instead of being stuck apart. As before, 90% of the time the offspring of such a "double het" will inherit both traits together. Almost 1 in 4 of their offspring will express both traits, as opposed to the usual 1 in 16. It will be difficult to separate them.

Sex-linked Traits

To compare the difference between normal single-locus traits and sex-linked traits, let's first review the behavior of traits controlled at a single locus. (Also known as *autosomal* traits.)

Figure 1 shows the results for an autosomal recessive trait where "A" is dominant to "a." Like before, FOIL can be used to determine the possible outcomes. Since the "a" mutant is recessive, only "aa" individuals are mutants.

Parents	Cross being performed	Mutant offspring
Normal Normal	AA x AA → AA	None
Normal Normal (het)	AA x Aa → AA, Aa	None
Normal Mutant	AA x aa→ Aa	None
Normal (het) Normal (het)	Aa x Aa → AA, Aa, Aa, aa	25%
Normal (het) Mutant	Aa x aa → Aa, aa	50%
Mutant Mutant	aa x aa → aa	100%

Figure 1 – Results of breedings involving a recessive mutant.

Figure 2 shows the results for an autosomal dominant trait where "a" is the wild-type allele. Only "aa" individuals are normal.

Parents	Cross being performed	Mutant offspring
Mutant Mutant	AA x AA → AA	100%
Mutant Mutant (het)	AA x Aa → AA, Aa	100%
Mutant Normal	AA x aa→ Aa	100%
Mutant (het) Mutant (het)	Aa x Aa → AA, Aa, Aa, aa	75%
Mutant (het) Normal	Aa x aa → Aa, aa	50%
Normal Normal	aa x aa → aa	None

Figure 2 – Results of breedings involving a dominant mutant.

Notice that the results do not differ between males and females. Each gender is just as likely to be any of the available genotypes.

The difference between males and females lies in the sex chromosomes, which in snakes are called the Z and W chromosomes. In corns, ZZ = male, and ZW = female. As a result of this difference, certain traits controlled by genes on these chromosomes will follow different rules in females versus males.

The reason for this difference is that there are loci on the Z chromosome that are not on the W chromosome. Since males have two Z chromosomes, the genes will be paired as usual and the trait acts like any other trait in males.

In females, a situation known as “hemizygous” exists. This is when there is nothing paired against the allele on the Z chromosome. It is unpaired because the other chromosome is the W and does not have that locus. As a result, whichever allele is present in a female will be expressed, even if it acts recessive in males.

“Lack of function” traits (similar to amelanism) are generally going to be recessive in males, but will not be recessive in females.

“Additional function” traits, which would often act like a dominant or codominant trait in males, will act somewhat like a dominant trait in females. However, it’s possible in these cases that the males (since they have two Z chromosomes) can receive a “double dose” of the allele where the females cannot. Because of that “double dose,” traits may show more extreme expression in males than females. It’s possible that this is the situation causing the pinkish colors on some anerythristic males, and/or the differences between male and female hypo lavenders.

In addition to the actual expression of the traits, the inheritance patterns will not be the same as usual. The following rules apply to sex-linked traits:

1- The female passes her W chromosome to all of her daughters.
2- The female passes her Z chromosome to all of her sons.
3- If a female is expressing a Z-based trait, it was inherited from her **father**. (Remember, she got the W chromosome from her mother.)
4- Females **cannot** pass any Z-based traits to any of their daughters.
5- Males can pass a Z-based trait on to their daughters or their sons.

These rules lead to some interesting consequences involving the way these traits will be distributed in hatchlings, depending on which parent(s) are carrying which alleles.

If we use a red Z to show the sex chromosome carrying a recessive mutant, the expected results are shown in Figure 3.

Parents	Cross being performed	Mutant offspring
Normal male Normal female	ZZ x ZW → ZZ, ZW	None
Normal male Mutant female	ZZ x ZW → ZZ, ZW	None
Normal (het) male Normal female	ZZ x ZW → ZZ, ZZ, ZW, ZW	*Females (50%)*
Normal (het) male Mutant female	ZZ x ZW → ZZ, ZZ, ZW, ZW	*Females (50%)* *Males (50%)*
Mutant male Normal female	ZZ x ZW → ZZ, ZW	*Females (100%)*
Mutant male Mutant female	ZZ x ZW → ZZ, ZZ, ZW, ZW	All offspring

Figure 3 – recessive Z-linked trait.

In figure 4 we explore the results expected from a dominant Z-linked trait. This time, the red Z represents a dominant mutant.

Parents	Cross being performed	Mutant offspring
Normal male Normal female	ZZ x ZW → ZZ, ZW	None
Normal male Mutant female	ZZ x ZW → ZZ, ZW	*Males (100%)*
Mutant (het) male Normal female	ZZ x ZW → ZZ, ZZ, ZW, ZW	Females (50%) Males (50%)
Mutant (het) male Mutant female	ZZ x ZW → ZZ, ZZ, ZW, ZW	*Females (50%)* *Males (100%)*
Mutant male Normal female	ZZ x ZW → ZZ, ZW	All
Mutant male Mutant female	ZZ x ZW → ZZ, ZZ, ZW, ZW	All

Figure 4 – dominant Z-linked trait.

If the trait is codominant, there will be three phenotypes in the males, but only two phenotypes in the females.

Ultramel

Current data from the results of breeding trials indicate that the hypo-like trait known as “ultra” is an *allele* to Amelanism. (See Genetics chapter to learn about alleles.)

Since this concept is often confusing to people who have only had to deal with simple-recessive genetics, this chapter explains the consequences of this discovery in detail. However, it cannot be explained or understood in the terms of simple-recessive genetics. It is necessary to have a grasp on basic genetics (including the true meanings of locus, allele, and het) before the information here can be properly absorbed.

To start off, let’s look at how amelanism has been known to work. There are two alleles that were known to exist at the “Albino” locus: normal and amel.

Allele	**Symbol**	**Max Melanin Production**
Normal	●	100%
Amel	○	0%

When these 2 alleles are paired in the 3 possible combinations, we get the familiar results:

Gene Pair	**Max Melanin production**	**Type**
● (100) ● (100)	200%	Normal
● (100) ○ (0)	100%	Normal (het amel and normal)
○ (0) ○ (0)	0%	Amelanistic

Notice that anything with 100% or more “max melanin production” is normal. This isn’t how much of the dark pigment it *does* produce, just how much it *can*.

Now, enter another mutation of the "●"gene, but this one can produce 25% of the normal amount of melanin. We'll call it "ultra."

Allele	**Symbol**	**Max Melanin Production**
Normal	●	100%
Amel	○	0%
Ultra	⊕	25%

When these 3 alleles are paired in the 6 possible combinations, we get a different set of results:

Gene Pair	**Max Melanin production**	**Type**
● (100) ● (100)	200%	Normal
● (100) ○ (0)	100%	Normal (het amel and normal)
● (100) ⊕ (25)	125%	Normal (het ultra and normal)
⊕ (25) ⊕ (25)	50%	"Ultra"
○ (0) ⊕ (25)	25%	"Ultramel" (het ultra and amel)
○ (0) ○ (0)	0%	"Amel"

Notice that two new morphs are now possible. These are the "ultra" which has about half the normal amount of melanin, and the "ultramel" (short for Ultra/Amel) which has only about a quarter as much dark pigment.

The other important point to remember about ultramels is that crosses involving both the amel allele *and* the new "ultra" allele will have results that will seem odd to those who haven't worked with allelic traits. It may seem complex at first, but it will become familiar soon enough.

Here are some sample crosses to demonstrate the results that differ from previous traits.

Amel X Ultra	⊕	⊕
○	○ ⊕ Ultramel	○ ⊕ Ultramel
○	○ ⊕ Ultramel	○ ⊕ Ultramel

As you can see, the offspring all inherit one amel and one ultra. These are "ultramel" hatchlings.

Amel X Ultramel	⊕	○
○	○ ⊕ Ultramel	○ ○ Amel
○	○ ⊕ Ultramel	○ ○ Amel

This time, half are ultramels, half are amels.

Ultra X Ultramel	⊕	○
⊕	⊕ ⊕ Ultra	⊕ ○ Ultramel
⊕	⊕ ⊕ Ultra	⊕ ○ Ultramel

Another split clutch, but this time the two results are ultramels and ultras.

Ultramel X Ultramel	⊕	○
⊕	⊕ ⊕ Ultra	⊕ ○ Ultramel
○	○ ⊕ Ultramel	○ ○ Amel

This clutch contains amels, ultras, and ultramels.

Ultramel X Normal	●	●
⊕	⊕ ● Het Ultra	⊕ ● Het Ultra
○	○ ● Het Amel	○ ● Het Amel

The key to this last clutch is that you are crossing a morph to a normal, and it is **not** true that the offspring are het for what the morphed parent is. Notice that half are *only* het for ultra, the other half are *only* het for amel.

Another very important point is that amelanistic cornsnakes cannot be het for ultra, **no matter what their parents are.** An amel corn is always this gene pair:

○○

To be het for ultra, a cornsnake must be one of these two types:

⊕○ (Ultramel)

⊕● (Normal, het Ultra)

The trick is that "het" has long been associated only with normal looking snakes, but that was only a coincidence. This is because until recently, only simple recessives were being dealt with. An ultramel cornsnake is, in fact, heterozygous. It is "single het" for ultra and amel. (It is not "double het" because it is only het at one locus.)

The last point of ultramel theory, and what may be the most confusing, is the issue of identification. If the above *ideal* situation exists, then ultramels will be easily distinguishable from ultras.

However, there is plenty of variation from each individual cornsnake to another, and it is likely that this will cloud the ID process. Since "typical" melanin content varies, the percent of desired melanin the ultra gene can produce would also vary with it. The results could be something like this:

Allele	**Symbol**	**Max Melanin Production**
Normal	●	100%
Amel	○	0%
Ultra	⊕	10% to 35%

Which creates the following mess:

Gene Pair	**Max Melanin production**	**Phenotype**
⊕ ⊕	20% to 70%	"Ultra"
○ ⊕	10% to 35%	"Ultramel"

Notice that in the above scenario, any snake between 20% and 35% could be either an ultramel or an ultra. In some cases, it might require breeding trials against an amel. (If amels are produced, it's an ultramel.)

Another potential stumbling block is that ultra's effects may be cumulative with those of Hypo type A. It is possible that a snake homozygous for Ultra and Hypo type A could match the description of an ultramel, causing additional problems in identification.

Since ID problems can already occur with "Hypo A" corns, "Striped Motley" types, as well as Anery A versus Charcoal, similar methods of coping with the problem will likely be necessary.

Conclusions:

The current results from breedings involving snakes identified as "ultra" have caused a great deal of confusion. Breeders were not able to make much sense out of their results when attempting to apply the usual ideas to crosses involving "ultra" cornsnakes.

Given the fact that mice, rats, and many other animals have similar genetic situations involving their albino locus, and that Dr. Bechtel (one of the pioneers of cornsnake genetics) had discovered an analogous situation in black ratsnakes, it seems likely that just such a thing should be found in cornsnakes, too.

Ultramel theory is currently "only" a theory, and may or may not turn out to be the perfect answer. But it appears to be an accurate and reasonable explanation at this point in time. If at some point in the future, new information provides a better model to help us deal with these crosses, it will be adopted.

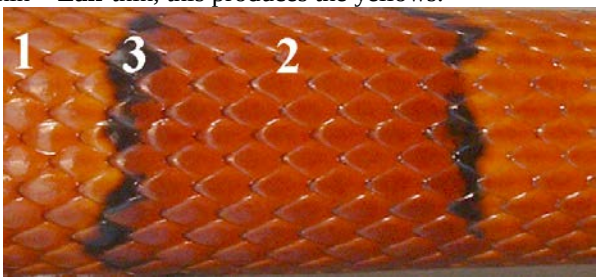
Until then, it is the author's suggestion to utilize this model, since it is the best way to understand and predict the behavior of the "ultra" gene/trait and is more likely to predict accurate results than anything else.

Normal Cornsnakes

In order to understand what variations there are, it is necessary to be familiar with the normal appearance of cornsnakes, including natural variations on the theme.

A normal cornsnake pattern is composed of three pigments:

- Melanin – **Mel**-uh-nin, this produces the browns and blacks.
- Erythrin – **Air**-ee-thrin, this produces the reds and oranges.
- Xanthin – **Zan**-thin, this produces the yellows.



- The ground color (1) is anywhere from light gray to tan to orange.
- The dorsal pattern consists of red (2) saddles.
- The saddles are outlined (3) in black.
- Starting from the edge of the belly to varying points on the side, there are generally one or two rows of side blotches.
- Often the blotches on the side are connected to either the dorsal saddles, or the lower blotches.
- Yellow pigment often grows in during the first year or two after hatching. It will be most visible on the sides of the jaw and neck.
- Two longitudinal stripes, generally a gray or “dirty” color, can appear along the length of the snake, at about the ten o’clock and two o’clock positions on the back.
- Two additional dark longitudinal stripes can appear, one along the middle of each side.
- The belly is similar to a basic black and white checkerboard pattern. Some color, usually red or a light red/tan, can wash over the white parts of the belly.

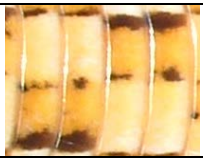
Hatchlings will start out with very little of the red, yellow, and orange coloration. To many beginners, hatchlings look like anerythristics or some “odd morph.” The saddles will be a deep burgundy or brown, and the ground color is in shades of gray or tan, with orange “dots” of color visible between the saddles, especially on the neck. The colors generally reach their peak when the snake is about 3 feet long.

There are many variations on this basic “normal” theme, all of which are still considered normal. They include, but are not necessarily limited to:

- Longer, shorter, wider, or thinner saddles.
- Fading out of two areas inside the saddles, one on either side.
- Fading out of a large area in the middle of the saddles.
- A few saddles being offset or smashed together, forming a **U** or **S** or **Z** or **W** shape.
- Thicker or thinner borders around the saddles. (Thinner borders can be gray instead of black.)
- White stippling around the outside of the black borders.
- Absent or more prominent “dark” longitudinal striping. This can also turn a light gray in adult cornsnakes.
- A great deal of variation of “general darkness” in the overall colors of the snake can be found among normals.
- Some belly checkers missing or bunched up.
- Belly checkers fading to brown, light tan, or reddish tan.
- A thin “stripe” of white running down the center of the belly.

		
White Stippling around saddles	Two saddles almost joined	Offset or joined saddles

	
Dark longitudinal striping is especially more apparent during shed cycles	Faded areas on sides of saddles

		
Belly with clear center	Faded Belly checkers	Missing belly checkers

Head Patterns

There is a great deal of variety in the head patterns of cornsnakes. Although this is generally not considered a major part of cornsnake patterns, colors, or genetics, these variations can be fascinating on their own. Some of the variants appear to be inherited like simple genetic traits.

- The basic arrowhead blotch is a "key." The key can be modified in several different ways.

- The lines that connect the different parts (top, middle, bottom) can be broken on one or both sides.

"Tulip" patterns (left) can be formed by a missing center. "Smiley" and "deadbolt" patterns (right) can result from breaks between the middle and the top.

- The top, center, or bottom of the blotch can be enlarged. This "crowning" tends to create points along the edges of the blotch.

Many "club" type patterns come from enlargement of the whole blotch. Notice the crowning points on each.

- The top, center, or bottom of the head blotch can be connected to the outside of the head pattern. This can come in the form of a complete connection, or just a tendency in that direction.

The "ringneck" (found in a lot of striped corns) connects to the outsides along the back end of the blotch. Connections can be made from the middle of the key, the upper sides, or the top.

This example shows five common places where the central blotch connects to the outside:
1- Top center.

2 & 3 – left and right upper connectors, in this example connected on the left side.

4 & 5- left and right middle connectors, in this example extended on the right.

Between these five, and the two where the "ringneck" is formed, there are a total of seven main connecting positions.

- In more extreme examples, often found on corns expressing the diffused pattern, a shape like a skull is apparent. It is often called a “scream” pattern because it resembles the white mask in the “scream” movies. Generally, the top point is connected, along with two pairs of points from the upper side, and the center. These leave only two oval-shaped spots.

(Left) Skull patterns on “pewter” and “bloodred” specimens.

(Right) Incomplete connection of the center can leave a heart shape.

Some head patterns are not as easy to classify. The first and second examples below (“twig and berries”) look to have a key with a broken center. The other two below, like the head patterns of many sunkissed corns, seem to defy the usual descriptions.

Some head patterns appear to be more common in certain morph types. This may or may not be a good indicator of the ancestry of a cornsnake, so in most cases it’s not a good idea to use it as a method of identification. So far, no serious work has been done on the inheritance of head patterns.

Community Projects

In 2004, a breeding experiment was organized by Joe Pierce. Several breeders – including Joe Pierce, Carlos Lahitte, Kat Hall, Don Soderberg, Connie Hurley, and the author – all coordinated their efforts to determine which types of "hypo" corns were compatible with each other. The first year's breeding trials were a success. The four known types so far are called Standard Hypo, Sunkissed, Lava, and Ultra. More test crosses will be done in 2005, and there will be attempts to match up compatible genes for the lines known as Dream, Christmas, Pumpkin, and Strawberry. Anyone wishing to become involved in any of these crosses, or to report any results, should contact the author via email: serp@cornguide.com.

Another experiment the author would like to run is to determine the phenotypes of offspring from Caramel and Hypo lines. There are often questions about whether normals het for these traits show part of the mutant phenotype, and it could be useful to try to determine if this is true or not. Anyone producing hets for these traits can get involved in the project. It will only require visually examining each of the offspring, assigning them a number based on "how much of the look they show," and reporting these results. Anyone wishing to become involved in such a project should contact the author via email: serp@cornguide.com.

Further studies are being planned for 2005:

- To determine the effects of dietary supplements such as carotenoids, which may or may not affect a snake's coloration.

- To determine the effects of probiotics, which may or may not aid in the growth of hatchling cornsnakes.

- To determine the inheritance of certain head pattern types.

These projects will require some work, but the results should be rewarding. Anyone wishing to become involved in any of the above projects should contact the author via email: serp@cornguide.com.

Simple Genetic Traits

To understand all of the genetic traits involved in corn morphs, it is vital to know how *all* types of traits work, not just recessives. This year's edition includes new ideas that are no longer explainable in terms of "recessive" genetics, or as the author has dubbed it, "psuedogenetics." The genetics chapter in this book is highly recommended reading for anyone wishing to learn how all of these traits work.

Traits are listed by locus, as this is the most logical way of grouping them. Readers unfamiliar with the terms *locus* and *allele* need to familiarize themselves with these concepts in order to work with genetic cornsnake morphs. Any explanation of genetics that does not include these terms is insufficient to deal with the reality of cornsnake traits as they are known today. Again, the genetics chapter in this book is highly recommended, and and the web tutorial is an additional resource.

The included pictures represent fairly typical examples of how each trait alters the normal appearance. As with any group of cornsnakes, there is a lot of variation among individuals expressing the same traits.

Amelanistic, aka **Amel**, **Albino**, **Red Albino**.
(*recessive*) ($20-$40)

This trait removes melanin, which is the black pigment. Areas where black would normally appear will instead be white, yellow, pink, or even "greenish" looking. The eyes are a distinctive glowing red/pink, except for a small dark spot toward the front of the eye.

Ultramel (short for **"Ultra/Amel")**
($100+)

Ultramels have an appearance intermediate between that of amels and that of ultra hypos, and are the most extreme-looking hypomelanistic corns discovered so far. Ruby-red eyes are often apparent in ultramels, and some can almost be confused with amelanistic corns.

Ultra aka **UltraHypo**
(*recessive*) ($100+)

Ultra hypos take on an appearance generally similar to other hypos.

The Albino locus:

Allele	Name
A^+	Wild Type
a^a	Amelanism
a^u	Ultra

Genotype	Known as:
$A^+ \cdot A^+$	Wild type
$A^+ \cdot a^a$	Wild type (Het Amel)
$A^+ \cdot a^u$	Wild type (Het Ultra)
$a^a \cdot a^a$	Amelanistic
$a^a \cdot a^u$	Ultramel (single-heterozygous for Ultra/Amel)
$a^u \cdot a^u$	Ultra

Hypomelanistic, aka **Hypo**, **Hypomel**, **Hypo A**, **Rosy**.
(*recessive*) ($20-$45)

This trait reduces melanin. The oranges and reds are generally "cleaner," the black borders are often thinner, and the belly checkers often are bronzed. However, these are not absolute indicators of hypomelanism and visual identification of adults can be tricky. If a cornsnake has lighter/cleaner colors, thinner than normal borders, or bronzed belly checks, it is not necessarily a hypo.

In some cases, the darkest hypos can be darker than light-colored normals. Hatchlings generally have a lighter brown/red tone to the saddles compared to normals. The best identification is made by comparing hatchlings, where hypos are generally quite obvious compared to non-hypo siblings. Some non-hypo corns will grow up to be extremely light, making identification of adults tricky.

The Hypo locus:

Allele	Name
H^+	Wild type
h^h	Hypomelanism

Genotype	Known as:
$H^+ \cdot H^+$	Wild type
$H^+ \cdot h^h$	Wild type (Het Hypo)
$h^h \cdot h^h$	Hypomelanistic

Sunkissed, aka **Hypo B, Sunkissed Okeetee, "Hypo Okeetee"**.
(*recessive*) ($40-$80)

Like hypomelanism, this trait reduces melanin. However, this is a mutation at a different locus than the one causing hypomelanism. Therefore, crossing sunkissed to hypomelanistic will **not** produce hypo offspring.

It is currently believed that cornsnakes expressing this trait will be indistinguishable from those expressing “regular hypo” unless the ancestry is known. That is, it is believed to *mimic* hypo. Currently, some corns are labeled as “hypo Okeetee” but are based on the standard hypo gene, not the sunkissed gene. Be sure you know which type of hypo you are getting if you plan to breed to other hypos.

The Sunkissed locus:

Allele	Name
S^+	Wild type
s^s	Sunkissed

Genotype	Known as:
$S^+ \cdot S^+$	Wild type
$S^+ \cdot s^s$	Wild type (Het Sunkissed)
$s^s \cdot s^s$	Sunkissed

Lava, aka **Transparent Hypo**, **Trans**
(*recessive*) ($80-$120)

This is the third hypo-like trait to be discovered. It acts similarly to the other two hypo traits in that it reduces melanin and creates a brighter overall appearance. It has not been outcrossed very far, and it could end up being indistinguishable from other hypo types. So far, it appears to have a more extreme expression and may not be another mimic of hypo. Hatchlings can appear almost amelanistic.

The Lava locus:

Allele	Name
V^+	Wild type
v^v	Lava

Genotype	Known as:
$V^+ \cdot V^+$	Wild type
$V^+ \cdot v^v$	Wild type (Het Lava)
$v^v \cdot v^v$	Lava

Other hypos:
Several other names for hypo-like corns are being used. A group of hobbyists, including the author, are working together to try to categorize all of these through breeding trials. Some of them are Christmas, Strawberry, Dream, and Pumpkin.

Anerythristic, aka **Anery**, **Anery A**, **Black Albino**, **Black corn**
(*recessive*) ($20 -$30)

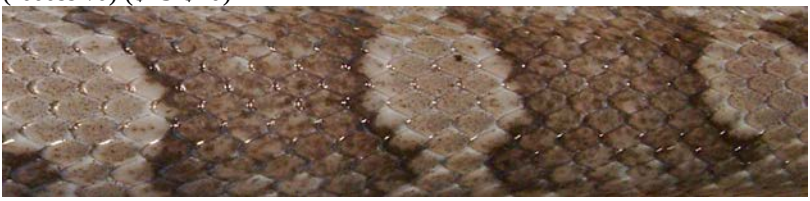
This is pronounced "**An**-ur-ee-**thris**-tik," or abbreviated to "**an**-ur-ee." This trait removes the red and orange colors, leaving the snake shades of blacks, grays, and browns. The typical yellows on the chin/neck/belly are unaffected. The cheeks often have a pinkish "blush" tone to them. A few red freckles may appear on the body of the snake. These usually appear after a shed, and can stay for the rest of the snake's life. Hatchlings are an attractive black and silver but the saddle colors often fade to browns, tans, or peach/pastel tones. Males are often more "colorful" than females.

The Anery locus:

Allele	Name
An^{+}	Wild type
an^{a}	Anery

Genotype	Known as:
$An^{+} \cdot An^{+}$	Wild type
$An^{+} \cdot an^{a}$	Wild type (Het Anery)
$an^{a} \cdot an^{a}$	Anerythristic

Charcoal, aka **Anery B**
(*recessive*) ($25-$40)



This was the second type of anerythrism to be discovered, and in many ways it mimics anery. Since this mutant is at a different locus from anery,

crossing anery to charcoal produces normal offspring. As in anerys, the cheeks often have a pinkish “blush” tone to them.

As a broad generalization, charcoals have a darker ground color and are lower in contrast than anerys. However, there is so much variation in both anery and charcoal that they often look similar to each other. Hatchlings generally have a purplish cast to them, and tend to look slightly different than anery hatchlings, enough to pick them out of a crowd. Adults often cannot be reliably identified by looks alone, so be sure you know which type you are getting if you plan to breed them.

A common myth is that charcoals do not develop yellow on the chin/neck and that anerys do. Originally this was true, but this myth has been dispelled as charcoals with yellow on them, and anerys without yellow, have appeared. The appearance or absence of yellow is ***not*** *a reliable way of determining the difference.*

The Charcoal locus:

Allele	Name
Ch^+	Wild type
ch^c	Charcoal

Genotype	Known as:
$Ch^+ \cdot Ch^+$	Wild type
$Ch^+ \cdot ch^c$	Wild type (Het Charcoal)
$ch^c \cdot ch^c$	Charcoal

Caramel
(*recessive*) ($30-$60)

Caramel appears to remove the red pigment. Many caramels have a yellow wash over the entire body. Some have no extra yellow, and it is unclear whether the extra yellow is simply the result of selective breeding, an influence of the caramel trait, or the result of a secondary trait.

The colors are generally in shades of brown, with the ground color being lighter with yellowish tones. Some hatchlings can look very similar to anerythristic hatchlings before the yellows appear.

Urban legend currently states that hets for caramel can be identified because they have more yellow than non-hets. There is no proof for this.

The Caramel locus:

Allele	Name
Ca^{+}	Wild type
ca^{c}	Caramel

Genotype	Known as:
$Ca^{+} \cdot Ca^{+}$	Wild type
$Ca^{+} \cdot ca^{c}$	Wild type (Het Caramel)
$ca^{c} \cdot ca^{c}$	Caramel

Lavender, formerly known as “Mocha.”
(*recessive*) ($75-$100)

As adults, lavenders end up with a pattern made of dark and light shades of an odd gray color. It is impossible to describe in words. Lavenders *must* be seen in person to be fully appreciated. Hatchlings can appear somewhat similar to anery hatchlings but have a lighter “brown” saddle color.

As juveniles, many lavenders will have an odd wash of ground color. This wash can be orangish, pinkish or purplish, and as they become adults it fades. Some lavenders will have ruby-colored eyes, but it is undetermined whether or not this is related to the lavender trait itself. Ruby eyes are not a sure-fire indicator that an individual is a lavender, since some *ghost* corns and other morphs also have ruby eyes.

Many lavenders, and normal corns from lavender lines, also have unusual patterns resembling *aztec* and *zigzag*. It is unclear whether or not this is directly related to, or linked to, the lavender trait. Normally patterned lavenders can also produce offspring with these odd patterns.

The Lavender locus:

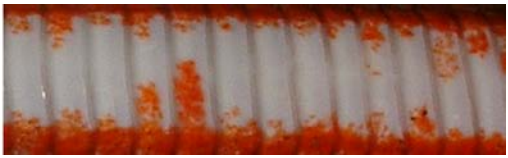
Allele	Name
L^+	Wild type
l^l	Lavender

Genotype	Known as:
$L^+ \cdot L^+$	Wild type
$L^+ \cdot l^l$	Wild type (Het Lavender)
$l^l \cdot l^l$	Lavender

Diffused, aka **Bloodred**, **Blood**.($65-$90)
(*variable codominant*)

Since this trait originally appeared in selectively bred corns known as bloodreds, the name "bloodred" is commonly used for the genetic trait.

The originators of the bloodred corns have suggested using the name "diffused" (or the "*diffusion*" gene/trait/pattern) in order to avoid confusing the genetic pattern mutant with the selectively bred color morph. Although the name "diffused" is not often used, this book uses that convention in order to separate discussions of the pattern trait from the selectively bred morph.



Three main effects on the pattern are observed. The belly is wiped clear of checkers. However, some black specks or freckles can appear. The head pattern is often stretched, and the top of the head can have a "skull" type pattern on it, or be stretched so far that there is no observable "pattern" on the head. The pattern on the side of the body can be practically normal, or almost completely blurred out. (The more diffused/blurred side patterns are usually more desireable.) The diffused pattern (like motley) often creates a mild lightening effect similar to (but not related to) hypomelanism.

Hatchlings start out with a lot of gray on the head and ground color, which then develops into the reds, oranges, or browns they will have as adults. In this morph, the ground color can become darker than the saddle color.

Diffuse acts like a simple genetic (autosomal) pattern trait, but unlike other traits, it isn't always recessive. The amount of expression of this pattern can vary widely between "het" specimens. Some appear normal, some almost fully express the diffuse pattern. Even the most extreme-looking hets generally do not express the "blurred" side pattern, and they will show traces of rectangular markings on the edges of the belly. Many breeders have also observed that in full clutches of known hets, male hets will show much more of the traits than the female hets. The differences may be obvious enough to identify males and females by looking at their patterns.

The Diffusion locus:

Note:"Bloodred" is the name most commonly associated with the expression of the trait referred to here as "diffusion." The less common term used here refers to the locus, and is used to make a clear distinction between the two different types of morphs that have the same name.

Allele	Name
D^{+}	Wild type
D^{D}	Diffusion (*commonly called "Bloodred"*)

Genotype	Known as:
$D^{+} \cdot D^{+}$	Wild type
$D^{+} \cdot D^{D}$	Intermediate (*ranges from normal to almost fully diffused pattern*)
$D^{D} \cdot D^{D}$	Diffused pattern (*commonly called "Bloodred"*)

Checkerless belly, typical of motley and striped corns

Motley ($m^{m} \cdot m^{m}$)
(*recessive*) ($30-$55)

The motley trait clears the belly of checkers. Some motleys will have a handful of checkers, and many will have black freckles on the belly. The dorsal pattern often shows a desire to stretch lengthwise. Anywhere from a handful of saddles to all of the saddles will be connected on the outside edges, creating circles along the back. Some normal (non-motley) corns have a “psuedo-motley” pattern on their necks, so the belly is important for proper identification.

The side pattern can be unaffected, or it can be smeared out into dashed lines. In some cases, the side pattern is virtually nonexistant. The motley pattern also creates a lightening effect similar to (but not related to) hypomelanism. That is, other morphs combined with motley, such as *anery motley*, *hypo motley*, *caramel motley*, etc. will often appear lighter than the same morph that does not express motley.

Be aware that the patterns produced by this trait are **highly** variable. This is why it is named *motley*. A wide variety of dorsal patterns can result, even in siblings from the same clutch.

Striped ($m^s \cdot m^s$)
(*recessive*) ($40-$70)

The striped trait has the same effect on the belly as the motley trait. The dorsal and side patterns will be made of four thin stripes running the length of the body. These stripes almost always have breaks in them, especially toward the tail end of the snake. Fully striped corns (with no breaks in the stripes) are uncommon.

Many striped corns will have an unusual head pattern that can resemble the head patterns of bloodred corns, often having a tendency toward an expanded head blotch, and/or tending toward the ringnecked pattern. As with motley corns, the striped pattern also creates a lightening effect similar to hypomelanism.

"Motley/Striped" or "Striped Motley" ($m^m \cdot m^s$)
($40-$75)

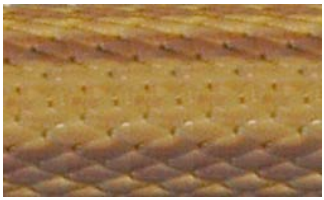
Generally the dorsal pattern ranges from motley-looking to somewhat striped-looking, or anywhere between those two extremes. It appears that the wider center stripe only occurs in cornsnakes homozygous for the striped allele. (That is "$m^s \cdot m^s$" cornsnakes.)

Selective breeding and line breeding of motley/striped cornsnakes has created some unusual and interesting patterns. Some of the results are covered in the section ***Selective Breeding Added to Genetic Traits***.

Striped Motley vs Striped
Some striped X motley (called "motley/striped" or "striped motley") individuals may have a long stripe running down the length of their body. These are not "striped" corns. The difference is in the width of the stripe.

Left: ($m^m \cdot m^s$)
Motley/Striped pattern

Right: ($m^s \cdot m^s$)
Striped pattern



True striped corns (also known as 4-lined stripes) have a wide stripe of ground color. Motley/Striped corns have a central stripe that is thin, or varying in width.

The Motley locus:

Allele	Name
M^+	Wild Type
m^m	Motley
m^s	Stripe

Genotype	Known as:
$M^+ \cdot M^+$	Wild type
$M^+ \cdot m^m$	Wild type (Het Motley)
$M^+ \cdot m^s$	Wild type (Het Stripe)
$m^m \cdot m^m$	Motley
$m^m \cdot m^s$	Motley-Stripe (single-het for Motley/Striped) (*ranges from motley to motley-striped appearance*)
$m^s \cdot m^s$	Striped (*Four-line stripe, or cubed*)

Selectively Bred Variations

Okeetee (Okeetee Phase) ($25-$50)

Pronounced "Oak-uh-tee." There are two main uses of this word:

The original meaning refers to a locality, and some people are interested specifically in corns from this locality. The stereotypical Okeetee corn has extremely bright orange and red colors separated by thick, bold black borders. Okeetees are generally considered the most attractive natural variation of cornsnake. They are also referred to as *Hunt Club Corns* or *True Okeetees*, in an effort to distinguish them from the second type. A new cornsnake registry (slated for late 2005) may help track the lineage of these animals to retain more of the locality information.

Another meaning has branched off from this, and is perhaps more common than the original. It refers to corns having the stereotypical "look" of Okeetee locality corns. Many of these have been produced. They will have some, little, or no connection to any corns from the actual locality. They are also referred to as "look-eetees" or "Okeetee Phase" in an effort to ensure the buyer doesn't assume they are locality corns. Cornsnakes cannot be het for Okeetee or Okeetee Phase.

Miami Phase ($25-$40)

The name "Miami phase" was coined to describe a look that is often found in corns coming from that area. The ground color is gray, tan, or somewhere between. Cornsnakes from anywhere can take on this look, so the name does not imply a locality, nor does any corn coming from that area automatically qualify as a "Miami phase." Hatchlings have a clean gray ground color. Individuals with the least traces of orange on the neck tend to generally turn out with the cleanest gray ground colors as adults. Cornsnakes cannot be het for Miami phase.

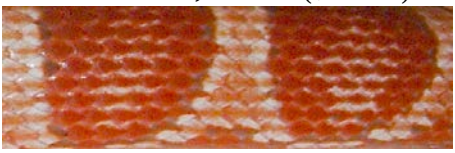
Upper Keys corn, Keys corn, Rosy Ratsnake ($30-$60)

Cornsnakes from the Florida Keys used to be classified as a separate subspecies. They tend toward an overall lighter appearance, similar to hypos. The belly checkering is generally not as strong, or is even absent. The ground color tends more toward shades of tan, and there is generally less contrast between ground and saddle colors. The black borders around the saddles are less prominent than in typical corns, or entirely absent. Cornsnakes cannot be het for “upper keys” or “rosy ratsnake.”

Kisatchie, *Slowinskii* ($50-$70)

These come from certain areas of Louisiana/Texas and are thought by many to be an intergrade between cornsnakes and emoryi ratsnakes. They have recently been classified as a separate species, *Pantherophis slowinskii*. Colors are in dark browns and grays and can look somewhat like very dark anerythristic cornsnakes. Cornsnakes cannot be het for Kisatchie.

Milksnake Phase, Banded ($30-100)



Banded cornsnakes (side view) have been bred to have wide saddles, or saddles which connect to the side blotches for a banded look.

The milksnake phase lines are intended to resemble eastern milksnakes. They were started with Miami corns, and as a result tend to have a light/clean ground color. Milksnake phase corns have also been crossed into motley lines.

Cornsnakes cannot be het for milksnake phase, or banded.

Aztec, **Zigzag** ($30-$100)


Two types of aztec patterns (above) and a zigzag pattern (below)

The zigzag pattern results from the left and right sides of the saddles being offset from each other, creating a “zipper” type of pattern. This can occur on anywhere from a single saddle to all saddles. Generally a snake is not considered a zigzag unless 80% or more of the saddles are zigzagged.

Aztec is an aberrant pattern that often has small pieces of colors strewn about, as if the saddles were made of glass and had been shattered. As with zigzags, a little, some, or all of the pattern may be affected, and individuals with a large amount of the aberrant aztec pattern are generally more valuable.

Some individuals will show both zigzag and aztec type patterning. Individual cornsnakes can show varying degrees of either of these patterns, and both types can mix and meld between one and the other, so there is plenty of gray area between what is considered zigzag and what is considered aztec.

Selective breeding of the most extremely patterned individuals generally creates the most extremely patterned offspring. These are very unpredictable patterns. Sometimes crosses – even between parents with the best patterns – produce normally patterned offspring. In other cases, normally patterned parents can produce extremely odd patterned offspring.

Cornsnakes with aztec or zigzag parents are commonly listed as “het” for zigzag or aztec. Do not assume they will produce these patterns in the same way as proven genetic traits do.

Other variations…

Many breeders selectively breed to establish certain looks in their own lines. When they are satisfied that a line is sufficiently different to warrant a name, they will apply one.

On the other hand, some breeders or resellers will simply apply a name in order to try to sell their product more easily, because it implies that the snakes are “special.”

Do not assume that a cornsnake with an unrecognized name is automatically special, but don’t assume it is a scam either. If you think they would be a good addition to a breeding project, ask the breeder some questions:

- What is special about the individuals with that name?
- How were they produced?
- Are there any known genetic traits involved?
- Do they “breed true?” (If I breed two of these together, will the offspring look like these?)
- Are there any other unusual or notable tendencies (good or bad) in that line?

Someone who has worked hard on a project will have a lot to say about them. Someone who has simply attached a name in order to sell something will not have much to say.

Either way, that type of corn still may be a good addition to your projects, but it’s helpful to have as much information as possible about what you are working with.

Combinations of Genetic Traits

Several genetic combinations have become common enough to have trade names. These are listed below.

Snow – amel and anery
Blizzard – amel and charcoal
Butter – amel and caramel
Opal – amel and lavender
Ghost – hypo and anery
Phantom or **Charcoal Ghost** – hypo and charcoal
Amber – hypo and caramel
Pewter or **Pepper** –charcoal and diffused
Ice Ghost – lava and anery

Note that the motley and/or striped patterns can be mixed with any of the color combinations. Since these two patterns are related, they are generally lumped together. Morphs with these patterns are usually denoted by adding motley or striped to the beginning or end of the name. For example, "striped snow," and "butter motley."

Below is a list of two-trait combinations. Not all possible combinations have been produced, and some have only been produced in small numbers so far. Some combinations are left out of this list because accurate descriptions are not possible until a good number of them have grown up to adult size.

Remember, there can be as much variation within any morph as there is between normal cornsnakes. The descriptions and photos are meant to be examples, and are by no means the limits of what could be created by selectively breeding a given trait combination.

Combinations with Amelanism:
Amel + Anery – ($20-40) **Snow**. This is one of the most common double morphs. As hatchlings, saddles are pink on a white background. If saddle borders are present, they will appear "clearish." As they mature, the saddle colors can fade in contrast, or turn a more pastel orange-like color. Saddle borders can develop yellow or mild "green" colors. Between these and the yellows and pinks, snow corns can be very colorful.

Amel + Charcoal – ($40-70) **Blizzard**. These are similar to snow, but generally have a less noticeable pattern and nowhere near as much color.

The saddles are a pinkish white. Hatchlings can appear virtually patternless. Yellow rings sometimes grow in around the saddles.

Amel + Caramel – ($50-75) **Butter**. As hatchlings, these can sometimes resemble snows. Butters can range in appearance from almost "snow-like" to almost "amel-like." Saddle colors tend to range from yellow to a dark brownish orange, and the ground color ranges from white or off-white to shades of yellow.

Amel + Lavender – ($100-150) **Opal** corns somewhat resemble snow and blizzard corns. In some, the ground colors are more colorful than the saddles, which can be almost white, and they look like a snow corn with the colors reversed. As with other lavenders, a wash of orange/pink can be present, especially in juveniles.

Amel + Diffused – ($75-$150) This combination is gaining in popularity for those who enjoy bright amelanistics. Several breeders are working to improve "sunglow" corns by adding bloodred/diffuse lineage into the morph. Some examples grow up to have very little or no white flecks on them.

Amel + Motley – ($30-50) Many of these tend to be very bright amelanistics. This combination is also known as "*sunglow motley*" when the ground color is a bright orange and white is absent.

Amel + Striped – ($40-60) Similar to amel motleys, striped motleys tend to be very bright in coloration.

Combinations with Ultra and Ultramel:
Most of these combinations are still unexplored. Caramels and motleys of the ultra and ultramel varieties have been created.

Ultramel + Caramel – ($???) These are similar to butter corns except the slight amount of melanin present makes them distinguishable from butters. The name "Gold Dust" has been coined for this combination. "Gold Dust Motley" corns also exist.

Ultramel + Motley – ($???) These snakes can be mistaken for amelanistic, but the eyes show that they are not amels.

Combinations with Hypomelanism:

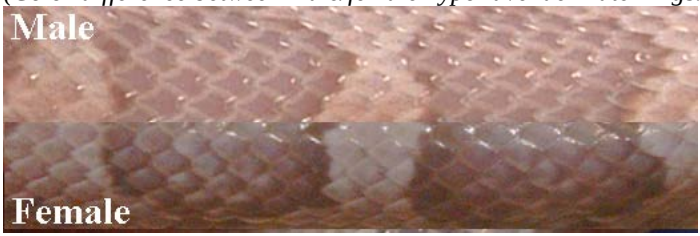
Hypo + Anery – ($25-75) **Ghost** corns are a lightened version of anerythrism. Colors often turn to light browns, tans, and some ghosts develop “peach” and other pastel colors. It seems that males are generally more “colorful” than females.

Hypo + Charcoal – ($40-50) **Phantom** or **Charcoal Ghost** corns are still relatively new on the scene. They tend to be slightly lighter in color than ghost corns, and some will develop “purple” or “lavender” type tones, similar to what is seen in younger charcoal corns.

Hypo + Caramel – ($50-80) **Amber** corns have light brown saddles on a tan to yellow ground color.

Hypo + Lavender – ($150-200) Youngsters expressing this combination are possibly the most bizarre looking corn morph to be found. The overall colors are lightened compared to lavenders, and the pink/orange wash that develops in young lavenders can be even more apparent. As shown in this male/female comparison, the males of this morph tend to be more “extreme” in their expression of the hypo trait. Females can almost look like regular lavenders.

(Color difference between male/female hypo lavender hatchlings.)



Hypo + Diffused – ($175-200) These are still relatively new and rare. It appears that the combination will produce corns of an overall lighter red/orange color than typical “bloodred” corns.

Hypo + Motley and Hypo + Striped – ($55-$75) The motley and striped traits already have their own “hypo-like” effect. Hypo adds to this effect, so that hypo motleys and hypo stripes are even lighter than normal motleys or stripes. Some adults have nearly identical ground and saddle/stripe colors, and can appear almost patternless.

Combinations with Sunkissed:
Since this is a relatively new trait, only one combination using sunkissed is known to exist yet. It was verified this year that Sunkissed + Hypo creates

two simultaneous hypo effects, making these snakes even lighter than either type of hypo.

Several traits have been crossed with Sunkissed so far and young hets are being raised for breeding. More new Sunkissed combinations – involving motley, anery, striped, caramel, and amel – should appear within the next few years.

Combinations with Lava:
Lava + Amel – ($???) These may appear sufficiently different from clutchmates, but may also appear sufficiently similar to other amelanistics that it is not possible to identify one by looks alone.

Lava + Anery – ($150-200) **Ice ghost** corns are relatively new and have not been outcrossed to many different lines. Currently it appears that ice ghosts will be a more extreme version of ghosts.

Lava + Charcoal – The first examples of these were hatched in late 2004.

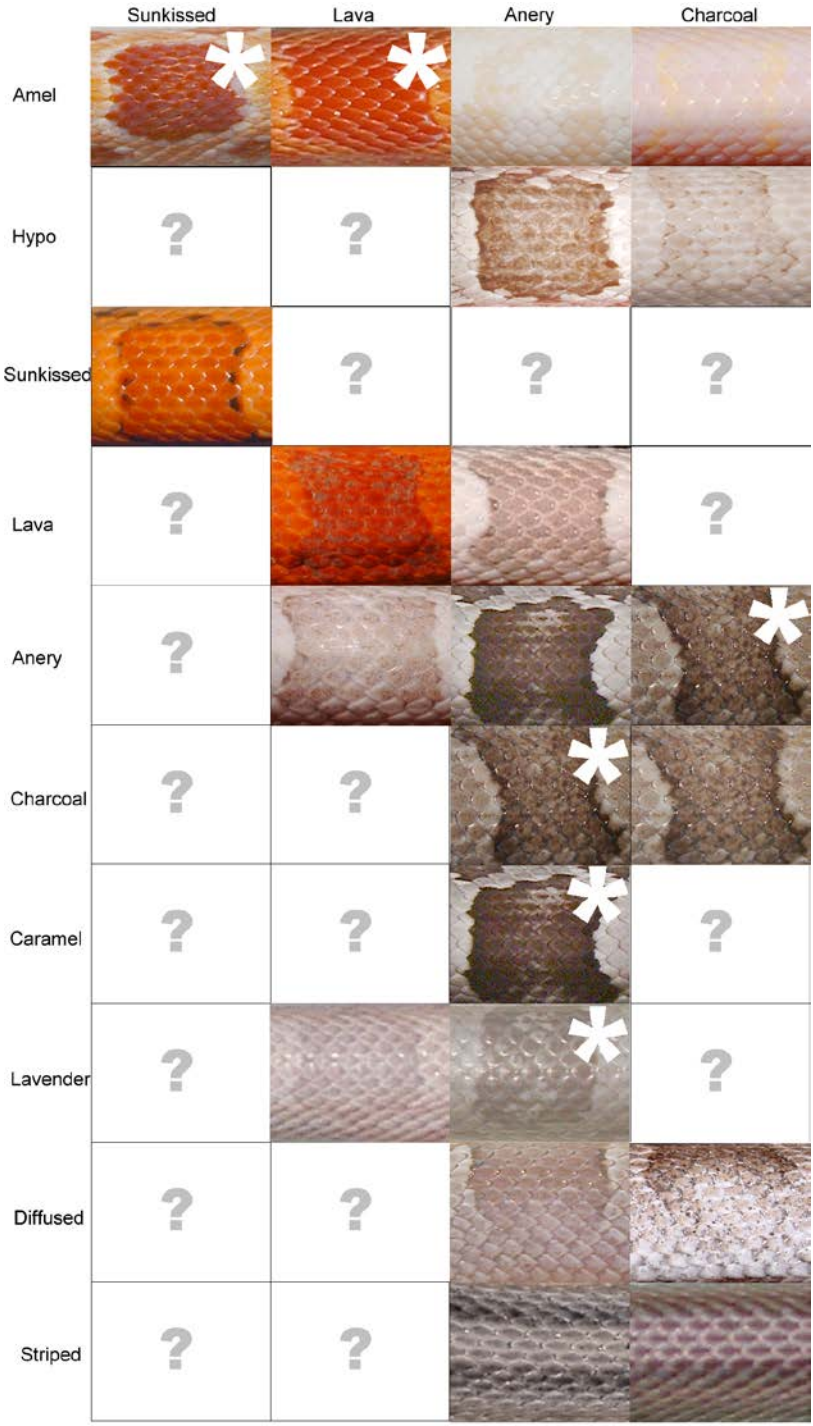
Lava + Lavender – ($???) Several of these were hatched in 2004. It appears that these may be an extreme version of hypo lavender.

Combinations with Anery:
Anery + Charcoal – ($???) It is almost certain that these are not visually identifiable. Current theory is that these will resemble charcoal corns, since the combination “amel + anery + charcoal “ looks like a blizzard.

Anery + Caramel – ($???) It appears that caramel is unable to exert its influence when anery is showing. That is, caramel is masked by anery. As a result, these individuals are expected to look like any other anery.

Anery + Lavender – ($???) Some cornsnakes are known homozygous for both traits, and look like typical lavenders. Additionally, corns of the triple combination of anery, lavender, and amel appear to look like typical snows. It is assumed that lavender masks the expression of anery, except when amel is present. There is still plenty of mystery involved in this combination.

Note: Starred * items denote that masking occurs or is suspected. That is, the combination of the two traits ends up with the same effect as having only one trait. The other trait is masked and has no effect.


Sunkissed
Lava
Anery
Charcoal
Amel
Hypo
Sunkissed
Lava
Anery
Charcoal
Caramel
Lavender
Diffused
Striped


Caramel
Lavender
Diffused
Motley
Amel
Hypo
Sunkissed
Lava
Anery
Charcoal
Caramel
Lavender
Diffused
Striped

Anery + Diffused – ($100-150)
Referred to (confusingly) by a few as “pewter,” but the more common use of “pewter” is to describe the combination of Diffused + Charcoal.

Some males of this morph can have odd “pink” tones to their sides. This tendency appears to run in families, and it can be obvious enough that males and females in these clutches can be visually identified based on their colors.

The name “Raider” has been suggested for this morph, referring to the “black and silver” colors and the “skull” head pattern.

Anery + Motley – ($40-50) Many of these are similar in coloration to ghost corns. Some anery motleys are referred to as “ghost motley” even if they are not expressing the hypo trait.

Anery + Striped – ($40-70) These are similar in color schemes to anery motleys. Some examples of this morph can become almost patternless. A few breeders are making an effort to produce totally “patternless” cornsnakes through this and a few other morphs.

Combinations with Charcoal:
Charcoal + Diffused – ($65-$150) **Pewter** corns range from very dark to very light. They are also occasionally referred to as “pepper” corns, because many will have tiny black freckles making it look like the snake is covered with pepper.

Charcoal + Motley – ($???) This morph is still in its infancy. It is unknown if these will resemble anery motleys, if they will take on colors similar to phantom corns, or if they will have a new look of their own. Charcoal + Striped corns were also produced in 2004.

Combinations with Caramel:
Caramel + Diffused – ($???) Several breeders have produced hatchlings of this combination. It is unknown what adults of this morph will look like, but a better picture of what to expect should emerge over the next few years.

Caramel + Motley and Caramel + Striped – ($50-100) As with other motley-based and stripe-based combinations, many of these tend to take on a “hypo” appearance and are lighter coloration than standard caramels.

Combinations with Lavender:
Lavender + Diffused ($???)– Only a few examples of this combination exist. Some appear to resemble light-silvery pewters and others resemble dark gray pewters, but with less of the “brown” colors.

Lavender + Motley and Lavender + Striped ($800-1000) – These are still hot items, since only a few of them exist. Both should become more common over the next several years.

Combinations with Diffused:
Diffused + Motley and Diffused + Striped – ($???) Since it is impossible to make a visual identification with certainty, these will need to be proven through breeding trials. No proven examples of these combinations exist to date, but several promising individuals exist, and some should be proven soon. The pictured “diffused + striped” sample is one of the promising specimens, and was produced by Richard Hume.

Additional combinations (including triple and quadruple morphs) are either in progress, entering the scene, or becoming more common. Here are some of the triple and quadruple morphs:

Snow Motley ($50-75)	Striped Snow ($100-150)
Striped Ghost ($85-$125)	Amber Motley
Butter Motley ($100-125)	Striped Butter ($750)
Opal Motley ($1000)	Striped Opal ($1500)
Hypo Pewter	Motley Pewter
Diffused Hypo Lavender	Anery + Hypo + Diffused aka “Ghost Bloodred”
Caramel + Amel + Diffused aka “Sulfur”	Diffused Striped Snow (Amel + Anery + Striped + Diffused)
Diffused Striped Amel	Diffused Striped Anery

Selective Breeding Added to Genetic Traits

Once genetic morphs become common, they are often selectively bred for certain distinctive characteristics. The first morph to appear, amelanistic, has also been selectively bred in more different directions than any other morph. In the future, many additional new morphs might be created by this same process.

Morphs using Amelanism:
Candycane ($45-85)

The idea is to remove the oranges and yellows from the ground color, leaving red saddles on a clean white background with striking contrast. Any ground color is undesirable in this morph, so they tend to resemble an amel version of the silvery Miami phase normals.

Candycanes are often divided into two types, red and orange. As shown above, the red or orange refers to the saddle color, and **not** the ground color.

Since the yellow and orange ground color grows in as cornsnakes mature, some clean-looking candycane hatchlings can grow up to look less than ideal. It is not possible to predict with 100% accuracy which ones will do this as they grow up. But as a general rule, the hatchlings with the least amount of yellow or orange ground color, especially on the neck, will tend to grow into more ideal candycane adults. An amelanistic cornsnake cannot be het for candycane.

Reverse Okeetee, Amelanistic Okeetee, Albino Okeetee ($35-55)

The use of the name “Okeetee” with this morph does not imply the Okeetee *locality*, just a look. A stereotypical Okeetee corn has bold borders on bright colors. The amelanistic version still has the bright orange ground color and red saddles, but the black borders have been “reversed” to white.

These are often bred mainly for the thickest possible white borders, with the ground color being secondary in importance. No cornsnake can be het for Okeetee, and likewise, amelanistic cornsnakes cannot be het for reverse Okeetee.

Sunglow, "No-white Amel" ($35-55)

The idea is to remove all traces of white, and to get a bright orange ground color. This creates a very bright red and orange cornsnake. Some breeders use hypomelanistic corns as a starting point, since many hypos have thinner borders. The motley pattern (used to create sunglow motleys) also tends to reduce the border thickness and get rid of a lot, or all, of the white. Some sunglow offspring will start out with white borders, which will then fade out as they mature. Amelanistic cornsnakes cannot be het for this look.

Morphs using Anerythrism:

Pastel Ghost, Pastel Motley, Pastel Ghost Motley ($50-100, varies)

Individual breeders use all of these terms differently. Generally it refers to softened pinkish saddles and/or ground colors on a number of different anery-based cornsnake morphs.

Some anerythristic motleys will get as light as ghosts and are sometimes referred to as "ghost motley" even though no hypomelanism is present. Some breeders will only use the term "ghost" when hypomelanism is present, and some will use the term based only on how light-looking the colors are.

It is a good idea to find out from the breeder which genetic combination is being expressed, especially whether or not hypo is being used in each combination. Until/unless a genetic influence causing the "pastel" look has been isolated and proven out, ghost corns cannot be het for "pastel."

Morphs using Motley and/or Striped:

Striped Motley, Cubed Motley ($40-$75)

When a striped corn is bred to a motley corn, the direct offspring take on a non-normal pattern. As a result, a *normally* patterned cornsnake can **not** be het for the motley and striped traits simultaneously. These offspring, or anything exhibiting a mix of both patterns, are generally called **striped motley**. The belly is uncheckered, and the dorsal pattern takes on a mix of both the striped and motley appearances. Some will look more like the

striped pattern and some will look more like the motley pattern. There is often a widening on the ends of the “stripes” creating a Q-tip appearance.

Generally, striped motleys can be distinguished from “true striped” corns by examining the width of the stripes. True striped corns (also known as 4-lined stripes) have a wide stripe of ground color. Motley/Striped corns have a central stripe that is thin, or varying in width.

Breeding striped motleys to striped motleys can create a great variety of patterns. One of these is referred to as **cubed**. It appears that these are striped ($m^s m^s$) cornsnakes.

Hurricane Motley (varies)
This variation of the motley pattern, also sometimes called *donut* motley, includes dark outlines around the circles caused by a thickening of the “border” areas, and/or fading of the central part of the saddles. Hurricane motleys come in several color morphs, and are generally priced significantly higher than normal motleys of the same color. Cornsnakes cannot be het for “hurricane.”

Compare the normal motley pattern (left) to the Hurricane pattern (right.)

Miami Motley ($???)

A few motley and motley/striped corns have been bred to take on the “Miami phase” look. This combines the motley pattern with a smooth silvery gray or light tan ground color. Cornsnakes cannot be het for “Miami.”

Morphs using Hypomelanism:
Crimson, Hypo Miami ($30-100, varies greatly with quality)
These are generally what you would expect from adding hypomelanism to a typical Miami phase cornsnake. The look, especially the ground color, can vary quite a bit depending on the stock a given breeder started with, and the direction they took their project. Some are clean gray, and others have a clean tan ground color. Hypos cannot be het for crimson or “Miami.”

Other variations:

Bloodred ($50-$95) *(side view)*

This term is also used as the name of a genetic pattern trait. Selective breeding of individuals expressing the "diffused" pattern trait had originally created extremely red individuals, which were practically patternless. But some of that quality has been lost in many lines.

Cornsnakes expressing the simple genetic "diffused" trait *and* cornsnakes selectively bred for the ideal look are both called "bloodred" corns by many people. There can be a great deal of difference in quality of patterning, so if you want the selectively bred "bloodred" morph, find out from the seller what you are getting. Since this morph is based on a codominant trait, some F1 offspring from "bloodred x normal" crosses can practically look like bloodreds themselves. *(See "Diffused," pages 44-45.)*

Generally, the best bloodreds will hatch with a completely patternless gray head or with a gray "skull" type head pattern, a belly with no black checkers or specks on it, side blotches that are very smudged or even invisible, and very little visible "black" anywhere on the pattern. As they mature, the grays slowly turn into reds. It can take 5 years for a bloodred to reach its "final" coloration. The snake pictured is a juvenile.

Pink and Green Snow, Green Blotched Snow ($50-80)

Some snows and amelanistics can have bright yellow saddles, and show a slight greenish cast in the areas where the black borders exist on normal cornsnakes. Some breeders have enhanced this trait through selective breeding. These are dubbed "pink and green" snows. They are sometimes referred to as "bubblegum" snows, although the "bubblegum" term can cause confusion because a line of hybrids is also referred to as "bubblegum." Cornsnakes cannot be het for "pink and green."

Coral Snow ($45-100)

Certain lines of "hypo snow" (that is, corns combining anery, amel, and hypo) will produce "coral" snow offspring. Some of these are almost as colorful as amelanistics. It is currently unknown whether or not the hypo trait itself is responsible for the appearance of the coral colors.

Hybrids and Intergrades

Breeding cornsnakes to many other species of North American snakes has produced hybrids and intergrades. The two most common crosses are with Emoryi ratsnakes, and California kingsnakes.

Creamsicle ($40-75)

This term has two meanings:

- It is generically applied to any corn/emoryi cross to denote that it carries emoryi blood.
- It is specifically applied to amelanistic corn/emoryi individuals. The pictured example is amelanistic.

Creamsicle projects are started by crossing an amel cornsnake to an emoryi ("great plains") ratsnake. These offspring are then either bred to each other, or to an amelanistic cornsnake. In the second generation and beyond, the amelanistic offspring (or any amel with an emoryi ancestor) are called creamsicles.

The name is a great description of their colors. They can have varying amounts of cornsnake versus emoryi blood, depending on whether they have been bred back to cornsnakes or to emoryi. The colors tend more toward red as more cornsnake is bred into the lines, and more yellow as more emoryi is bred into the lines.

Rootbeer ($ 20-???)
This name has more recently caught on as a name for corn/emoryi crosses that are not expressing any genetic traits. Several other traits, including hypo and motley, have been bred into these intergrades.

Jungle Corn ($???, *varies greatly*)
This name is applied to crosses between cornsnakes and California kingsnakes. Defying a strict definition of hybrids, these are **not** typically sterile. Second generation offspring (and beyond) have been produced from these hybrids. Amel, snow, motley, and other varieties of jungle corns are known to exist.

Coming Attractions

Many claims of "new" morphs are made each year. Almost all of them quickly disappear and are never heard of again.

If a "new" morph is based on a proven genetic trait, it will catch on sooner or later. The name coined by the originator/discoverer will often stick, but sometimes a "better" name will be applied and become more popular.

If a "new" morph is based on a selectively bred variation of an existing morph, it has to pass the market's unofficial "brown bag" test in order to be accepted. The brown bag test works like this: put 25 miscellaneous corns, and 5 corns of this morph, all together in a brown paper bag. Then ask yourself, "Would the average buyer be able to sort through and pick out the 5 individuals of the new morph?" If not, it is unlikely to catch on as a new morph because people won't remember it. In effect, enough people have to believe it is distinctive from existing variations that they will accept it as "new" and use the suggested name, earning it a place in the market and among hobbyists.

Some odd appearances are currently being investigated by different breeders, and could prove genetic within the next few years…

- **"T+ Albino"** – This term vaguely describes many forms of amelanism or extreme hypomelanism in any species. Ultramels are one known example that fit the definition. There are potentially dozens of unrelated mutations that could fall under this category.
- **"Paradox Albino"** – An amelanistic cornsnake with some black areas. This should not happen on an "amelanistic" cornsnake, but in some individuals it does. Hence the name "paradox."
- **"Piebald"** – Also called *pied*, this trait replaces random patches of the snake's normal pattern with solid white.
- **"Leucistic"** – A patternless white snake. This trait, like piebald, exists in many species and will inevitably show up in cornsnakes.
- **"Wide Stripe"** – Several breeders are trying to determine the mode of inheritance of this aberrant pattern.

- A trait with an appearance similar to that of Anerythrism was discovered in some Upper Keys corns. It appears to be genetic, and unrelated to Anery and Charcoal.
- An odd corn with very little red and a lot of yellow coloration—similar to but not necessarily the same as caramel corns—was caught in the wild in North Carolina. Breeding trials to determine its heritability will most likely begin in 2005.

Buyer Beware

People are always searching for new traits. This is always exciting, but problems can occur when it is assumed that all unusual appearances are caused by genetic traits. Here are some scenarios:

- An odd hatchling or hatchlings come from normal parents, and a breeder assumes it is a genetic trait. Since the parents don't look like the offspring, it is then assumed that the "genetic" trait is recessive and both parents are hets. The siblings not showing this "trait" are then labeled as "possible het." They are sold at a premium price because they are "possible het" for a new cutting-edge trait.
- An odd specimen is caught in the wild. When the offspring don't show this same oddity, it is assumed that there is a recessive trait at work. Again, the offspring are sold as "hets" for a premium price.
- A breeder has a name applied to a line of selectively bred corns. A buyer or reseller who isn't familiar with the name then sells the individual(s) with the name attached. The next person assumes it is a genetic trait. Offspring of that animal are sold as "hets."

The problem is that the above scenarios are based on the assumption that anything with a name, or anything odd or unusual, is genetic. This is **not** a safe assumption, since many cornsnakes hatch out with odd patterns or colors due to any number of non-genetic causes. Unusual incubation conditions appear to be the most common cause.

In order for a trait to be proven genetic, it must be reproducible in some predictable way. This can take several years from the time the first specimen is discovered. A simple rule to go by is: *if there are not grandchildren expressing the same look, it cannot be assumed to be a simple genetic trait.*

A recessive trait will not appear in the first generation of offspring, but will reappear when the normal-looking offspring are either bred to each other, or back to a parent.

A dominant or codominant trait will appear in the first generation, in either all the offspring, or about half of the offspring. However, selectively bred looks can also affect first generation offspring, so it is necessary to outcross further in order to determine what type of inheritance pattern it follows.

Additionally, cornsnakes will be sold as hets for Miami, Okeetee, Green Spot, Hurricane, Keys, Kisatchie, Banded, Aztec, Zigzag, Candycane, and other selectively bred looks. Cornsnakes cannot be het for these qualities.

Further Reading / Hyperlinks

A support website for this book is located at **http://cornguide.com.** A message board on the site allows readers to communicate with each other and the author with questions, comments, and feedback about this guide. An online genetics tutorial is there, too.

A monthly cornsnake newsletter was started in 2004. Among its regular articles is a "Morph of the Month" with lots of information about that particular morph. Information about the newsletter, including how to subscribe, is available at: **http://cornguide.com/newsletter**

Online forums, where you can have a dialogue with other cornsnakers, and browse a huge and ever-growing photo gallery of cornsnakes, are located at: **http://www.cornsnakes.com**

Several handy programs (for Windows) that predict the outcomes of morph breedings exist. Three of them are on the web:
http://mywebpages.comcast.net/spencer62/cornprog.html
http://www.marcelpoots.com/CornWiz/GenWiz.htm
http://www.kornnatterlexikon.de

The Corn Snake Manual, by Bill and Kathy Love contains a great deal of information about caring for and breeding cornsnakes, and historical information about the origins of many of the morphs, along with a lot of quality photos. It can be found at many bookstores and reptile shows, or you can order it online directly from the authors at:
http://corn-utopia.com

A Color Guide to Corn Snakes by Michael McEachern is an old but useful book. It can be found at amazon.com.

A web search for cornsnakes will bring up a lot of breeders' sites. Many of them have pictures and information about the morphs they produce and sell. This is a good way to become familiar with the names and looks and varieties. The following websites are a good starting point:

http://serpenco.com
http://cornsnake.NET
http://corn-utopia.com
http://www.vmsherp.com
http://swreptile.com

Morph Listing

This list covers all commonly known morphs to date, along with some up-and-coming developments.

Amber	50-80	Caramel	30-60
Amber (Motley)		Caramel (Motley)	50-75
Amel	20-40	Caramel (Striped)	70-100
Amel (Motley)	30-50	Caramel Diffuse	
Amel (Striped)	40-60	Charcoal	25-40
Amel Diffuse	75-150	Charcoal (Motley)	
Anery	20-30	Charcoal Ghost	40-50
Anery (Motley)	40-50	Creamsicle	40-75
Anery (Striped)	40-70	Crimson	30-75
Anery Caramel		Diffuse	65-90
Anery Charcoal		Diffuse (Motley)	
Anery Diffuse	100-150	Diffuse (Striped)	
Anery Lavender		Ghost	25-75
Aztec	30-60	Ghost (Striped)	85-125
Banded	75-100	Ghost Bloodred	
Blizzard	40-70	Hypo	20-45
Bloodred	50-95	Hypo (Motley)	55-70
Butter	50-75	Hypo (Striped)	60-75
Butter (Motley)	100-125	Hypo Diffuse	175-200
Butter (Striped)	750	Hypo Lavender	150-200
Candycane	45-85	Hypo Lavender Diffuse	

Hypo Pewter		Opal (Striped)	1500
Ice Ghost	150-200	Pastel (Ghost)	50-100
Jungle Corn		Pastel (Motley)	50-100
Kisatchie	50-70	Pewter	65-150
Lava	80-120	Pewter (Motley)	
Lava Lavender		Phantom	40-50
Lavender	75-100	Rootbeer	20+
Lavender (Motley)	800	Snow	20-40
Lavender (Striped)	1000	Snow (Coral)	45-100
Lavender Diffuse		Snow (Motley)	50-75
Miami Phase	25-40	Snow (Pink/Green)	50-80
Miami (Hypo)	50-100	Snow (Striped)	100-150
Miami (Motley)		Striped	40-70
Milksnake Phase	30-45	Striped Motley	40-75
Motley	30-55	Sulfur	
Motley/Striped	40-75	Sunglow	35-55
Normal	10-40	Sunglow (Motley)	65-100
Okeetee	25-50	Sunkissed	40-80
Okeetee (Hypo)	30-50	Upper Keys	30-60
Okeetee (Reverse)	35-55	Ultra Hypo	100+
Opal	100-150	Ultramel	100+
Opal (Motley)	1000	Zigzag	35-100

Answers to Genetics Practice Problems

Page 10-11:

1. A △▲ Normal	B ▲▲ Normal	C △△ Shows Triangle trait
2. A □■ Shows Square trait	B □□ Shows Square trait	C ■■ Normal
3. A ◇◇ Shows Diamond trait	B ◆◆ Normal	C ◇◆ intermediate (Diamond/Normal)

Page 20:

1 Aa.	**2** Aa, aa.	**3** Aa, AA.	**4** AA, Aa, aA, aa.	**5** AaBb.

6-

	Aa	**aa**
Bb	AaBb	aaBb
bb	Aabb	aabb

7-

	Aa	**aa**
BB	AaBB	aaBB
Bb	AaBb	aaBb
bB	AabB	aabB
bb	Aabb	aabb

8-

	AA	**Aa**	**aA**	**aa**
BB	AABB	AaBB	aABB	aaBB
Bb	AABb	AaBb	aABb	aaBb
bB	AAbB	AabB	aAbB	aabB
bb	AAbb	Aabb	aAbb	aabb

9- AaBbCc.

10-

	Aa	**aa**
Bb	AaBbcc	aaBbcc
bb	Aabbcc	aabbcc

11- (step 1)

	Aa	**aa**
Bb	AaBb	aaBb
bb	Aabb	aabb

11- (step 2)

	CC	**Cc**
AaBb	AaBbCC	AaBbCc
aaBb	aaBbCC	aaBbCc
Aabb	AabbCC	AabbCc
aabb	aabbCC	aabbCc

12- (step 1)	**AA**	**Aa**	**aA**	**aa**
BB	AABB	AaBB	aABB	aaBB
Bb	AABb	AaBb	aABb	aaBb
bB	AAbB	AabB	aAbB	aabB
bb	AAbb	Aabb	aAbb	aabb

12- (step 2)	**CC**	**Cc**	**cC**	**cc**
AABB	AABBCC	AABBCc	AABBcC	AABBcc
AABb	AABbCC	AABbCc	AABbcC	AABbcc
AAbB	AAbBCC	AAbBCc	AAbBcC	AAbBcc
AAbb	AAbbCC	AAbbCc	AAbbcC	AAbbcc
AaBB	AaBBCC	AaBBCc	AaBBcC	AaBBcc
AaBb	AaBbCC	AaBbCc	AaBbcC	AaBbcc
AabB	AabBCC	AabBCc	AabBcC	AabBcc
Aabb	AabbCC	AabbCc	AabbcC	Aabbcc
aABB	aABBCC	aABBCc	aABBcC	aABBcc
aABb	aABbCC	aABbCc	aABbcC	aABbcc
aAbB	aAbBCC	aAbBCc	aAbBcC	aAbBcc
aAbb	aAbbCC	aAbbCc	aAbbcC	aAbbcc
aaBB	aaBBCC	aaBBCc	aaBBcC	aaBBcc
aaBb	aaBbCC	aaBbCc	aaBbcC	aaBbcc
aabB	aabBCC	aabBCc	aabBcC	aabBcc
aabb	aabbCC	aabbCc	aabbcC	aabbcc

13- aa = ¼. bb = ½. cc = ½, dd = ¼. Total is 1 in 64.

14- aa = ½. bb = ½. cc = ½. dd = ½. Total is 1 in 16.

15- aa = ¼. bb = ¼. cc = ¼. dd = ¼. Total is 1 in 256.

16a- aa = ¼. bb = ¼. cc = ¼. dd = ¼. Total is 1 in 256.

(Ax means Aa, aA, or AA.)
(Dx means Dd, dD, or DD.)
16b- Ax = ¾. bb = ¼. cc = ¼. Dx = ¾. Total is 9 in 256.

Index

The 2005 Edition begins to unravel the Mysteries of several forms of hypomelanism. A new era in cornsnake morphology is launched as the most popular genetic trait is found to have a partner...

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