The More Detailed Look At the Chestnut Factor

By Dr. R.H.J.J. Geurts
Reprinted with permission from:
The International Phryso, vol 3, no 2, April 2000

In a recent telephone interview, Dr. Reinier Hubert Joseph Jules Geurts expanded on some of the points within his article about the chestnut factor in the Friesian population. As he explains, approximately 4% of the Friesian mare population carries the chestnut factor, but it is not a problem to breed them; in fact, it is now not even a worrisome issue in breeding. This is due to the fact that the stallions approved for breeding must first be examined to see if they carry the factor. Those few that do are not allowed to participate at the Central Exams in order to prevent further breeding difficulties due to the chestnut factor. As the following article explains, there are still Approved Stallions breeding who carry the chestnut factor and it is only then that the mare's factor comes into play. According to Dr. Geurts, the existence of chestnut factor carriers, AND the policy to not breed to stallions who are chestnut factor carriers, has established an equilibrium in the total mare population - a balance that is not a problem in the gene pool. "It is important that new breeders understand this."

"Chestnut foals," states Dr. Geurts, "are beautiful Friesian foals, but only black is acceptable in the studbook. Our black Friesians have no other small factor for variety of chestnut - only dark chestnuts are going to be born from that small percentage possible. Purebred Friesians have no other factor coming forward to express itself. This means the mane and tail are the same chestnut color as the body."

After a 70-year history of breeding only black foals, the birth of two chestnut foals in 1991 came as a surprise to many. At that time, we provided an explanation for this phenomenon in the form of an article published in Phryso (1991, no. 6). Since that time, chestnut foals have been born almost every year. This has prompted taking a closer look at the breeding policy to be conducted in conjunction with this undesirable color. This article, thus, goes into this subject in more detail.

A Definition of Hair Color

For the sake of clarity, we will first discuss the basic colors of the horse. Sometimes people speak of a 'brown' Friesian horse, while the accepted term is actually 'chestnut.' It is best to refer to hair color according to the genetic complex of factors that determines color. A brown horse carries the brown factor (A) that is dominant over black in the sense that the black pigment is limited to appearing in the hair of the mane, tail and the lower legs. The rest of the coat is not black but can range from light to very dark brown or reddish brown. Many years ago, brown occurred among Friesian horses, but over the years, the A factor has disappeared from the population and as a rule cannot recur. Chestnuts lack black pigment so the A factor cannot be expressed, although it is carried invisibly. Chestnuts occur among other breeds in all kinds of shades, the color being related to several factors. Among Friesian horses, chestnuts display an even color with manes and tail the same color as the rest of the coat.

How Chestnuts Occur

Among today's Friesian horses, we are dealing with only one pair of factors. One of these is the black factor, 'E' (meaning the extension of black pigment over the entire coat). The other is the chestnut factor, 'e' (meaning that no black pigment is generated and that only red pigment is generated). 'E' is completely dominant over 'e' ('e' being what we call 'recessive'); this is indicated by the use of capital and lowercase letters. This means that a horse with both of these factors ('E' and 'e', one from each parent) will appear black but that it will still carry the recessive factor. In this case (Ee), the horse will not always 'breed true' in terms of its appearance: it will not always produce black offspring. If a horse will 'breed true in terms of black,' we indicate this with the designation EE. If a horse will 'breed true in terms of chestnut,' we indicate this with the designation ee. An Ee animal produces two kinds of reproductive cells: half with E, and half with e. A horse breeding true for black (EE) produces only one kind of reproductive cell, E, so that even if this horse is bred with an Ee horse, the offspring will always be black. Only by mating two Ee horses can a chestnut be produced: 3 to 1 in favor of black, meaning that the chance of producing a chestnut is 25%.

Reproductive Cells			
Stallion		**E**	**e**
Mare	**E**	EE	Ee
	e	Ee	ee

From this diagram, we can also see that for the last mating listed, the chance of producing an Ee offspring is 50% while the chance of producing an EE offspring is 25%. In addition, mating an EE horse to an Ee horse will mean a 50% chance of producing an Ee offspring.

The Frequency of Ee horses

The occurrence of chestnuts within a population ('population' meaning all the animals participating in breeding) of black animals also means, therefore, that the Ee combination is found among both mares and stallions. This has always been the case.

In our previous article, we explained by means of the Hardy-Weinburg model commonly used in population genetics, how it is possible that even after such a long time, chestnut foals can still be born. This model assumes that in a population in which unlimited mating is possible, the factors E and e will occur at a certain frequency, usually indicated as fractions of one: E as a fraction of p, and e as a fraction of q, so that p+q=1. When mating occurs, offspring are produced in the following proportions (that result from the development of {p+q} squared): p squared (EE): 2pq (Ee): q_squared (ee). This is a proportion that maintains itself from generation to generation so that a balance exists. Because we want to know the frequency of q (or p), and it is impossible to separate the EE and ee animals from one another, we have to look at the ee animals (the chestnuts).

It has now been 8 years since the first chestnut foals were born. And they have continued to appear. During this period, more than one stallion has also been shown to be Ee. This situation meets the conditions of the Hardy-Weinberg model so that the calculation of q becomes more reliable. During the 1991 through 1998 period, we know of the birth of 9 chestnut foals. Compared to the total number of foals born during these years, we can calculate that q=0.02. The number of Ee animals in the population can then be calculated as follows: 2pq = 2 x 0.02 x 0.98 = 0.039, or 3.9%. For the breeding population, this means that 4 in 100 mares should be Ee. This low value for q scarcely varies even if we select only in favor of black horses and start each new generation by breeding EE x Ee. After eliminating chestnuts through selective breeding over n generations, q will be q: 1+nq. After ten generations, thus, q will be 0.017 and 2pq will be 0.033.

The Future

The substantial increase in breeding over the last 8 years as this relates to the number of foals born (the number has more than doubled), and the number of new mares included in the studbook (increased by a factor of 1.75), and a situation in which Ee stallions are also participating, will mean that we can expect an increase in the number of chestnut foals being produced. This tendency can already be observed: of all known chestnut foals born, 6 of them were born in 1995. The chance of producing a chestnut foal from an Ee stallion increases as this stallion sires more offspring. (To illustrate the situation, we can compare what is going on now - with Wicher producing 245 foals in 4 years of stud service and Atse producing 216 foals in his 3 years of stud service - with Freark producing only 189 foals in his entire 19 years of stud service.) Much more importantly, the number of Ee mares will probably increase gradually if measures are not taken to limit this. This can also be shown by the following calculation: during the years 1993 through 1998, there were 5160 new mares included in the studbook, 225 of these being daughters produced by an Ee stallion. Of 4935, the number of Ee will be 4%, or 197. Of 225, however, this will be 50%, or 113. From this group of mares, the total number of Ee offspring can be expected to be 310, or 6%, and this means an increase of 50%. An increase in the number of Ee mares results, in turn, in more chances for the birth of chestnut foals. It was by considering these figures that the Studbook Board decided, and rightly so, not to admit any more Ee stallions into the breeding program. At this time, three of these stallions continue to provide stud services. This means that we can still expect to see a certain number of chestnut foals being born.

Pedigrees

When the first chestnut foals were born, the foal's pedigree could not be used to indicate the source of the chestnut factor. Soon, however, Freark (and Ysbrand, his half-brother out of the same dam) was suspected. As based on DNA studies using material still available at the Van Haeringen Lab, it has now been proven that both of these stallions carried the chestnut factor. All Ee stallions now identified can be traced back to Freark through their sire's or dam's line. Likewise the mothers of the chestnut foals (of which 2 can be traced back to Ysbrand), usually over two or three generations. We might wonder why none of Freark's direct offspring, produced over his 19 years at stud, were chestnut foals. If he indeed produced no chestnut foals as direct offspring, a possible explanation might be that Freark did not sire that many foals per year (never more than 20). In addition, it is also possible that the region that he served was limited with the added coincidence that few Ee mares were located there. Since it seems extremely probable that his sire, Ritske, was EE as based on the many black foals he sired, his dam must have been the parent carrying the chestnut factor. Through her, we can trace back through three lines to arrive at President 123. We know for certain that this stallion carried the chestnut factor since he sired a chestnut foal out of a black dam in 1920. It is not possible, however, to trace the chestnut factor back any further with any degree of certainty.

Removing Risks

Considering the number of brood mares, it would naturally be unfeasible as well as unnecessary to conduct an extensive investigation into the chestnut factor among all of them. Armed with the data from the pedigrees of the stallions with the chestnut factor and the pedigrees of the chestnut foals themselves, we already have useful information available to us: what are involved are six mares sired by Freark and 1 sired by Ysbrand.

- Continued on page 37 -

Chestnut Factor - cont. from page 29

We should not forget that the chestnut factor could also have been passed down through other lines, even though this has not occurred until now. Of Freark's daughters, 75 were included in the studbook: a manageable number, it seems to me. Half of these will carry the chestnut factor, and these in turn will pass it on to half of their daughters. Studying the lines issuing from these mares is definitely worthwhile; in an individual case, one could have a DNA test conducted if this were deemed necessary. In any case, such testing would be recommended in combinations that would produce more chance of a chestnut foal. As an example, if a breeder might see advantages in breeding his Diedert mare with Wicher, Jillis or Abe and vice versa, this would be a risky combination. After all, his mare has a 50% chance of being Ee. If she is, the risk of her producing a chestnut foal is 25%. If he wants to remove this risk, he should have his mare tested for the chestnut factor. The decision made by the Studbook also has consequences for those involved in producing breeding stallions. In their case, however, they can determine this in an early stage (even before purchase) by having a test run to ascertain if the foal carries the chestnut factor. This should definitely be done in the case of a colt sired by an Ee stallion and in the case of a foal with a pedigree that can be traced back to Freark daughters or to mares which have been known to carry the chestnut factor.