

Open House at the Nagel Family in Germany



50 Years of Katharienthof On the Development of

“The pedigree is only an estimate
of ancestry and genetic merit.”

Samantha Brooks

Breeding With no End in Sight the “NK Arabians”

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Even if Straight Egyptians from Dr. Nagel's Katharinenhof have been sold all across the globe, his breeding operation has never, from its beginnings up to today, been a business model. Rather, it has always been a cultural contribution for maintaining and developing those Arabian horses which originated from the Southern part of the Nejd on the Arabian peninsula, and were imported to Cairo from there. Almost none of these original Arabian horses has a written pedigree that reaches back for more than 150 years. Which makes the 50 years of Dr. Nagel's methodical, well thought-out and designed hobby breeding operation into a documentary milestone, a landmark well worth mentioning within the history of the Straight Egyptians world-wide. A feat that commands respect, as there is not another stud in the world – apart from the foundation stud of El Zahraa in Cairo – that can take the credit for having a breeding history of the same experimental and, at the same time, scientifically sound scope.

The fifty-year anniversary of Katharinenhof Arabian horse breeding in July 2018 was on one hand a summary of the efforts in selecting Arabian horses with a certain typical look in the past, and on the other hand an opening of a new chapter, in which traditional breeding methods and new scientific knowledge will be joined. This fact found its expression in the agenda of this event.

Right at the start, some documents were distributed which were meant to help in language problems and in understanding. The morning started with a long-expected talk held by Prof. Samantha Brooks from the University of Florida, USA, concentrating on the applications of different DNA analyses for exploring the past of the breeding stock of the Arabian horse, and for giving valuable assistance for further breeding decisions. (Find a summary of her talk, written by Gudrun Waiditschka, after this article.)

The talk was followed by a presentation of stallions, broodmares and foals, arranged according to mare families and gets of stallions.



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Dr. Nagel, the founder, owner and brain behind all these achievements and 88 years of age by now, prepared his Arabian herd for this future/scientific program for decades. He decided on a concept which differs from all other existing breeding programs; it is in fact unique worldwide. Some steps similar to the measures taken in Katharinenhof can be found in some other studs; however, they cannot be considered as a special or complete program, as they mostly seem just to happen. In Katharinenhof stud, on the other hand, there is a complete, well-considered concept being carried out, based on a closed population and a limited number of breeding stock, as these are the key premises for such a concept to be able to function and bring the expected results.

If one examines the traditional part it should be known that Dr. Nagel is one of the very few people who knows both: Horse breeding in modern times, and the rules and habits which prevailed in the Arab countries as far back in history as it can be known. For more than 20 years, he was president of the German Arab Horse Society and in this capacity involved in setting up breeding requirements, evaluation procedures, and rules and regulations in the frame of the official legislation. Also, during his 10 years term as a president of WAHO, most of the Arab countries have been accepted as WAHO members.



I asked Dr. Nagel to explain the results of his breeding to the readers himself:

Dr. Nagel, you were president of WAHO for a long time. When WAHO set themselves the task of registering the Arabian horse stock in the countries of their origin, how did they implement that?

Nagel: "WAHO sent inspection committees into these countries to evaluate the local, traditional Arabians and to decide which of them were eligible and which had to be refused due to poor qualifications. It goes without saying that many valuable, but also many surprising decisions had to be taken during this procedure of investigating, and a lot was learned, particularly on the subject of how the older generations of breeders in these countries looked at their horses. These committee visits allowed me a good look into various Arabian horse populations. "

So your WAHO time was an important factor in setting your path as a breeder. Will you tell us more about that path? To start at the beginning, can you tell us why you go back to the origin of the Arabian horse in the Arabian Peninsula?

Nagel: "My aim in breeding is to create a



homozygous population. This requires a lot of time and many generations. It is therefore advantageous to go back to a breeding stock which most probably has already generated a certain degree of homozygosity. This is expected to be the case concerning those horses which came from the Arabian Peninsula during Abbas Pasha's time. They fulfilled the conditions to be a limited number which existed only in that area and within the Bedouin society. The offspring of these horses finally, at our times, found their home as breeding stock in the El Zahraa stud of the EAO in Cairo. Most probably, they carried the desired characteristics in them already, and it was very advantageous



to build my concept and selections on such favorable conditions. In this respect, the Egyptian Arabian population is in fact unique, I would not know any Arabian horses population in any other Arab country, which would offer the same advantages.

As a consequence of my experiences in the Arabian countries, my insight into Egyptian Arabian breeding became ever stronger and I got convinced that a closed population program, which I had in mind, would be the most successful option, particularly if it were to be based on well-selected mares from this Egyptian breeding population. However, the Arabians belonging to this population also needed to be carefully studied, since it is composed of different families and partly strongly influenced by various stallions. Another advantage was the fact that this Egyptian population was limited in EL Zahraa, and for nearly 70 years, no other stallions and mares had been added to this herd. Around 1950/60 only approximately 70 broodmares and about 5 stallions were used in the breeding process.

Consequently, I watched this Egyptian breeding herd carefully for five years, from 1963 to 1968, until I decided which horses should be chosen as proper broodmares. It took me an-

other 15 years of progeny testing at my own farm, Katharinenhof, until I was sure which horses were the most suitable ones. From then on, I let no other Arabian from the outside enter into this selected group anymore."

You mentioned as well that you studied the El Zahraa population very thoroughly, and it is known that you were expertly advised by Dr. Ameen Zaher, the breeding advisor at that time. What was his contribution?

Nagel: "A lot of my knowledge I owe to this person. He advised me to choose my Arabians from the so-called "heritage group" in El Zahraa. At that time the El Zahraa management divided their population in the so called "heritage group" and in a newly selected group, which was more required for riding and racing. The stallions which represented the "heritage group" were the sons of their famous stallion "Nazeer". Consequently, I chose all my mares from this group: Daughters of Nazeer sons. "

Where does inbreeding turn up in the historical contexts you mentioned?

Nagel: "Abbas Pasha collected his horses in the middle of the 19th century. In comparison to the





horse breeding in the northern Arab countries, like Syria or Iraq or former Palestine, where horses lived in larger herds, the number of Arabians on the Arabian peninsula was small due to adverse living conditions, as there were very limited natural resources such as food, grazing grounds etc. Therefore, a lot of closed breeding must have happened due to this smaller number; today one would say “inbreeding” was everywhere. Even in human society, in the Bedouin clans, people married mostly within their relative group and intermarriages (between close relatives) were practiced and were even an obligatory rule in certain clans.

For all humans and animals, nature was a strong selection force and only the fittest and healthiest ones could survive. Therefore, the seed for a certain “inbreeding resistance” was cast in such populations and got manifested in them. This is the historic and traditional aspect of my belief.”

So what, in summary, was the strategy which you used for your own breeding work?

Nagel: “Well, the historic and traditional aspects I just mentioned were just what I needed to have a solid stud for my closed breeding concept. Therefore I trusted in the Egyptian Arabians and in those horses which proved to fulfill my requirements.

Step 1: To study the families within the El Zahraa breeding stock, including all their relatives and offspring which lived still in the farm, in order to find my preference,

Step 2: To make sure that these families were free from any hereditary diseases such as CID, CA or Lavender disease,

Step 3: To control my choice by progeny testing later at my stud. These were the three basic steps to arrive to my closed population, which is now the breeding herd at Katharinenhof. This herd consists of four proven stallions and sixteen to twenty broodmares and selected fillies.”

What were your specific considerations, how did you structure your approach? Particularly, do you put more emphasis on individual traits or on the traits of families in your breeding?



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Nagel: "I consider the mares and their families to be the stronger parts, I see them as a base and when I look for improvement, I take care that this improvement will not destroy the basic features and structures of such a family. Concerning my choice of stallions, offspring of such families as well, each one must have one or two highlights, positive features, which are wanted and desired as an improvement and which fortify the quality of the offspring. If a stallion has such good points, but is not able to transmit such quality to his offspring, he will be not used anymore."

Despite of all other breeding considerations, you based your decisions on your knowledge of your individual horses?

Nagel: "Concerning my breeding decisions, which have been taken to arrive at the present

situation, from the beginning until today, with other words during the last 50 years – well, I came to know every horse very well, including its character and its behavior. I tried to recognize if a certain horse tended to be similar to his sire, his dam, or to one of his grandparents. This is guessing, but also proper guessing is a matter of experience and will gain in accuracy the longer one works with a certain horse."

In your inbreeding scheme, which were the closest mating you would use?

Nagel: "The closest breeding, which happened and was applied from time to time, was a half-brother to half-sister combination. All other mating were lower considering the degree of close breeding.

All these means of choosing and selecting are common procedures and methods, which are applied also in selection programs in any animal breeding, and when they are used in horse breeding and particularly on Katharinenhof Stud, they have to be adapted by introducing certain changes and adjustments.



Savie

THE SCIENTIFIC ASPECTS

Some of these adjustments, if I got that right, were triggered by the latest scientific findings in breeding and selection based on DNA analysis.

Nagel: "Yes, that is true. After proper examination and several discussions with experts working in this field, I decided to use this knowledge and these new developed tools for selection in my Katharinenhof breeding concept. It turned out, to me, that such procedures are particularly useful and enlightening when they are applied in a closed population with a limited number of horses. "

What exactly does DNA analysis have to do with your horse breeding strategies?

Nagel: "This DNA analysis of an animal or horse reveals a lot. It shows the genetic composition of a horse concerning its parentage. It discloses the traces of any ancestor belonging to its own breed or population, and also those which belong to a different Arabian horse population or even to another horse breed; a very delicate tool, since Arabian

horse breeders claim the Arabian is a pure breed horse.

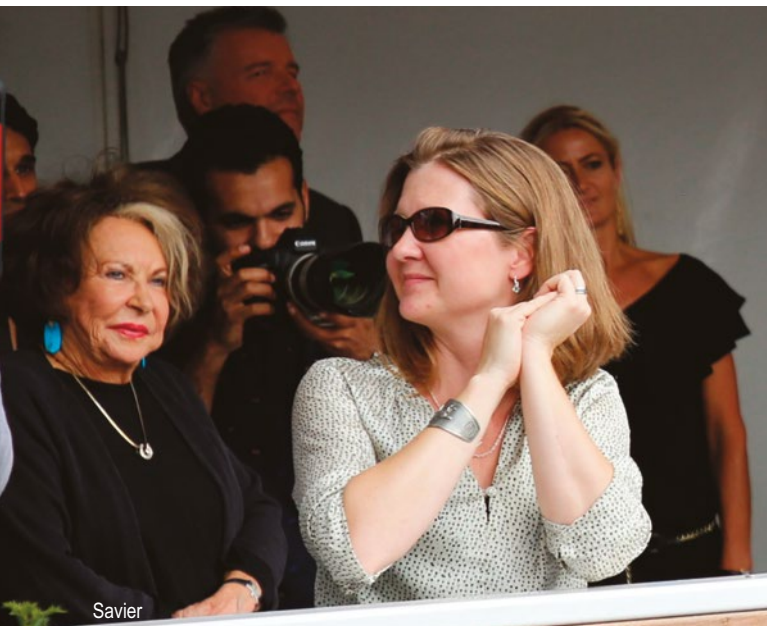
When a group of horses like the EL Zahraa breeding herd is bred over certain generations in a closed way, it develops sooner or later its own markers and clusters, visible in a DNA analyzing process. If purposely programmed, it also reveals the influence of all horses, the ones in closer generations and the ones far back in history. It also shows that different Arabian horse populations have common ancestors and that certain horses still have such a relation to such ancestors or that they could have vanished due to selection in the course of time. There are certain famous Arabian horses, which were used in different breeding populations, like Risalla or Risla, two Rodania mares of Crabbet breeding, or the Egyptian Stallion Aswan. One can find the names of these horses in the Egyptian, Polish or Russian breeding studs and they might show up in a DNA programmed analysis. Therefore, there could be traces of Polish, Russian or Egyptian horses in any of these



three above-mentioned breeding programs. Such influences could be heavy and might be disturbing, when they come to the surface, however they are a fact.

A population, which is composed of different origins and therefore heterozygous probably shows a lot of influences of other Arabian breeds or even non-Arabian breeds, which might have entered directly or indirectly in such populations in the course of time. For sure such studies will appear more frequently in the future, some interesting ones are already published and when most of these facts are on the table, it will be very difficult for certain groups as Blue list Arabians, Asil Arabians or other certain Arabian horse groups which are worshipped by their breeders, to hold their claimed position and arguments and the popular strain concept of Carl Raswan will be possibly one of the first to collapse with all what people have build on it. It had been revealed by DNA studies that due to the fact that Katharinenhof Arabian horse population has been closed for thirty years and several generations have passed, this population has

reached its own particular status - a unique sub-group- within the larger total Egyptian population. This status developed over time and this herd became more and more a homogeneous group. This developed at a much slower pace than expected. In this specific DNA study this trend is much less expressed in comparison to the commonly applied "in-breeding index", a mathematic formula, where this index increased at a much more rapid rate, which does not reflect the reality. Besides the above aspects, the DNA offers an ideal assistance in the context of breeding and breeding decisions. Based on a color scheme, it reveals the relation of a horse to its parents or it might reveal which gene material, having its own importance in a population (clusters), can be found in a certain horse. Full sisters may show the same color configuration, but they can also be totally different. On paper they are both the same, contrary to the reality. Therefore, no mathematic formula can match such results based on biologic material. Such a study was proposed at the time by Prof. Samantha Brooks of the University of Florida and parts



of the study were shown to the partly surprised and partly highly interested audience of the Katharinenhof talk. The raised questions if this type of analyzing and revealing would take away a lot of the romance in the history from the Arabian horse, should be answered: it does not. The Arabian horse remains untouched in its own merit, it will lose nothing from its beauty, from its force and stamina, nothing from its beautiful character and its charm. However, such analyzing will prevent that this horse is used to lure admirers and believers into programs and concepts which are unrealistic and mere fictions and possibly driven by other interests. “

You had a lot of courage to submit your Arabian horses at Katharinenhof to such an analyzing and checking procedure by applying this DNA program. Keeping in mind that the “purebred issue” is so strongly fixed in the mind of people, were you not scared about unfavorable results?

Nagel: “In fact, I could not know the outcome but I was very certain the results would turn out positively. My belief was based on the reason that in the course of my breeding time of 50 years, about 500 foals were born in total in my stud, which are enough horses to draw reliable conclusions. Three things would have disturbed me a lot:

- A horse which would grow significantly to a higher body size, maybe up to 160cm and more
- A horse that would display a color I would not be familiar with, a color very strange compared to the usual colors in my stud.
- A horse with a larger head, with a tendency to have a convex forehead, smaller eyes, longer ears.



I have seen such horses in other populations and I am not sure if such features are an indication of an unknown influence or if they are just a different type of Arabians. An answer could be given by applying a DNA analyzing program. There are existing several articles and there is literature which reveal that in certain Arabian breeding programs, breeders have to select severely against such features – mainly height - in order to bring such a population always back to those criteria which are typical and a kind of standard of an authentic Arabian horse. It can be assumed



at the same time that the existence and the appearance of such features will also indicate a low degree of homozygosity. “

You have presented your breeding results to the public three times by now:

- on the occasion of the tribute to your famous stallion Salaa El Dine in 2003,
- in your Open House which also presented the publishing of your last book “The Arabian Horse – Nature’s Creation and the art breeding” in 2013, - and now, the fifty-year anniversary celebration in 2018.

The public which were present at that event and which have seen your horses now noticed that there was good progress. Where would you like to grow from here on?

Nagel: “Even if my population is small, it is well based. I have four root families, which are similar to each other, but not identical. This can be seen by their appearance as such, by their pedigree documents, and now - of high importance - by knowing their genetic composition through DNA analyzing. This is a new fantastic help, which came up surprisingly; now it makes all my work easier and the concept even more solid.

The present study reveals that the degree of homozygosity in my population is not at all progressing as expected; from this point of view there remains is a lot of room to go forward. Besides this knowledge there is the very traditional practical aspect of selection. Any negative trait, if it would appear—although very unlikely – should be recognized immediately, very carefully examined under all considerations and, if necessary, such horses should be removed from breeding. In applying all this knowledge and these precautions, and due to the fact that the genome of a horse is enormously rich and offers millions of possibilities, it will take generations even in a closed program to reach the limits.

It remains therefore a lot of time and many opportunities to enjoy the pleasure of breeding and selecting Arabian horses. Such efforts are rewarded a million times when waiting each year for a new crop of foals and youngsters in all their beauty, with all their elegance, their temperament and their grace; all of them are so many good points, which one likes to see in full harmony with each other. “

About 300 visitors were sitting and standing around the presentation paddock, waiting to see and to evaluate the Arabians, which

THE PRESENTATION



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were chosen this time in order to give an idea of the Katharinenhof breeding concept. Dr. Nagel himself commented on these horses for more than two hours, and once in a while a piece of well selected music accompanied the presentation of the horse groups.

Dr. Nagel, you explained that you work now with four strongly selected mare families. What are your considerations for maintaining these families?

Nagel: "Each one of them presents a certain strain in Egyptian breeding: my largest family is the Hadban Enzahi, the next one the Siglawi, followed by a smaller group of Obayan, and finally the Dahman Shawan group. In principle, every group should be of the same size, four to five mares, however, horses are not machines or computers, one has to live with the delicate biological procedures and one has to accept what nature gives and offers. If mares are producing too many colts, a family will not grow, if however

a lot of females are born, a family grows perfectly and quickly. Also, if you don't want your key mares to be with foal every year, or if one of them might be lost, this also slows or stops the growth of a family. When differences in the size of families show up, it takes a lot of consideration and patience to work with such circumstances in a closed program.

The total breeding herd of 20 mares and young female as replacements is completed with five to six stallions, all members of the Nazeer sire line. For 30 years now, Katharinenhof stud has kept this size and remained unchanged."

The other part of breeding is the stallions, and you have four major stallions now which you presented to your visitors. What are your comments on them and their daughters?

Nagel: "I started the presentation with these four major stallions entering the paddock as one group: The grey NK Nadeer; his young



full brother, the very dark bay NK Nizam; then followed the bay NK Kamer El Dine; regrettably his full brother, the grey Jamal El Dine, could not be shown, as he is in Kuwait. The last in this group was the bay NK Nabhan, a NK Nadeer-son. All four horses expressed an excellent Arabian type, known as the NK Type, as many people call it. These horses are of a lighter bone, medium size, they show powerful movements and all of them are well tempered. Most of the applause went to the 13year old NK Nadeer, and no doubt to his five year old son NK Nabhan, the most elegant Arabian in this stallion presentation”.

As the next picture each of the above stallions were shown with their daughters. The most uniform group were the five daughters of Jamal El Dine. All of them of grey color, all with a nice, high-set, long neck and a fine attachment; this was the most common feature of all. Between them, the mare NK Abla with her exciting , striking movement made the best impression, however, it was difficult to grade them into first or second ones. The second group were the female offspring of NK Nadeer. Mares in three different colors: grey, chestnut and black. In total six mares and out of them three full sisters: NK Nina, NK Nachita and NK Nouna.



Again there was one mare which the spectators liked a lot: the grey NK Nachita, a six years old mare, maybe she will be the next star in the Katharinenhof stud. This position is still occupied by NK Nadirah, a grey Adnan daughter, 17 years old, a unique mare, not perfect in total but unsurpassed

in charm and presence, a typical example of an oriental mare with her own charisma. The third group was the NK Kamar El Dine offspring. There were two full sisters, NK Lina and NK Lateefa, both chestnut, then the two further full sisters NK Nouna and NK Bt. Bt. Nashua, and finally the last two



full sisters NK Nawal and NK Nakybia, both daughters of NK Nadirah. In this group one could recognize to which mare family each presented mare was belonging. Only the very dark bay NK Nawal represented clearly her sire NK Kamar El Dine in perfection in her deep bay shining color,

with somewhat shorter legs, but with a wonderful expression in her face and with her black eyes, the largest ones in the stud. Then followed the offspring of the young NK Nabhan, who has successful offspring that has appeared on Arabian shows worldwide. They were four fillies, one year old.

This was his first crop of foals born in 2017, together with three colts, which were shown later on, all in one group. This lot of foals proved the prepotency of this attractive sire. All fillies got his longer legs, his beautiful fine neck, his elegance in conformation - being light and slender and his typical

Arabian head. NK Naala must have been very special somehow, since most of the people mentioned this mare in later discussion again and again. The youngest stallion NK Nizam, a very dark bay full brother of NK Nadeer, had only one colt with him, NK Ibn Nizam, born in August 2017; a very



appealing, correct little horse, nearly black; already at his age well balanced in every aspect, with an exciting movement. He got the full attention of most of the visitors.

You presented your mare families next. You can probably tell us a lot about them?

Nagel: "Yes, in a second round mare families were presented. The Hadban group consisted of three major broodmares with their offspring: NK Nadirah, NK Nasrin and NK Bint Bint Nashua. Each of these mares has three daughters in the stud: NK Nadirah with her daughters NK Nawal, NK Nakybia



and NK Naala. NK Nasrin with her daughters NK Bint Bint Nashua, NK Nouna and NK Nazli, and finally NK Bint Bint Nashua with her three daughters NK Nina, NK Nachita and NK Nounou, all by NK Nadeer. All of these families were shown in one group in order to evaluate them as a total and to have an opportunity to compare about the general appearance of each family”.

The same applies for the Obayan group, the Siglawi group and the Daman Shawan. One could easily recognize, that each family had a great similarity within itself and still one

could also see that each family has its own particular features.

After the mare families all the NK Nabhan foals of 2017 entered in the ring, this time the four fillies again with additional three colts. Still the same pictures: All seven youngsters were clearly stamped by their sire NK Nabhan. They appeared in two colors, three grays and four bays. Between the bay and the grey foals were certain differences, but very small ones. Only somebody with a good trained eye could possibly detect such variations. The presentation





came to its end and finally the foal crop of 2018, as far as they were born already by this time, were brought into the paddock. All these foals were NK Nabhan offspring, except NK Lateefa with her little colt by NK Nizam of this year. This group of Nabhan

of this year confirmed the same stallion power when it came to two points: longer legs, very fine longish necks and a beautiful expression in their heads. In this last group, the show was stolen by a seven days old black filly, named NK Naya, she was by



NK Nabhan out of NK Nina, both her parents sired by NK Nadeer. However, her dam families are quite different. The stallion NK Nadeer proved in this filly his high quality as a very valuable sire. During all this time of presentation, all visitors enjoyed

the wonderful sunshine creating a pleasant relaxing atmosphere around the Open House which most of the people are certain to remember for a long time – at least until the next legendary Open House event on Katharinenhof stud.





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A Look Behind the Pedigrees

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Photos: Monika Savier

During the “Open Day” at Katharinenhof Stud, **Prof. Samatha Brooks** of the University of Florida gave a very interesting presentation on modern genetics. To understand the novel options breeders may have in the future, one has to look at the basics of genetics first: The genome of a horse - or any other organism - contains the code of life. The majority of it is needed to support all the various functions of a cell, with many cells combining into tissue and ultimately building an organism. This “text” of a genome contains 2,7 billion individual pieces of genetic code, that transcribe into 20.000 genes, of which only about 3% have so far been decoded and understood. These genes determine, for example, height, coat color or genetic diseases, performance, etc. 97% of the “text” is not yet known, but it contains information on how, where, when a gene will function. Any gene can contain variations, resulting in traits like grey or non-grey, etc. It is presently possible to scientifically test for 16 different coat colors, 35 coat patterns, 14 traits of “qualities” such as movement and performance, 30 areas that are connected to diseases (e.g. SCID, CA, LFS), and 13 areas associated with complex diseases (OCD). Unfortunately, only few can so far be utilized by breeders, as they are not yet marketable.



Traditional breeding vs. modern genomics

The traditional way of using pedigree information and performance records to assess the value of the ancestry of a specific horse is a very inaccurate tool with regards to the breeding potential of that horse. This is not because these records may be wrong, but a pedigree describes only one theoretical option, while nature creates new life on the basis of probabilities. We all know, for example, that full siblings don't necessarily look the same. This is due to the probability for each gene to have been contributed either from the sire or the dam. It is just a matter of chance, which gene is was contributed by whom. With genomics, you can analyze and then visualize just how much genetic material originated with which parent. If, for example, you think about replacing the dam due to her age, and you have two fillies, full siblings, out of her, they look all the same by pedigree. But with genomics, you can determine which of the two daughters is more like her mother in her genetic make-up.

Another example is inbreeding. For many years, breeders and researchers have assessed the amount of inbreeding according to the pedigree and calculated a figure from that, the “inbreeding coefficient”. So the inbreeding coefficient is a term used to describe the degree of inbreeding in an individual. Now research has revealed that this is highly inaccurate: Samantha Brooks analyzed the Nagel herd with genomic measures but also calculated the inbreeding coefficients in the traditional way. The correlation between the pedigree-based degree of inbreeding and the actual DNA-calculated value of inbreeding was very low, which means that the traditional inbreeding coefficient is quite inaccurate. The research group also measured the actual homozygosity of four full siblings (i.e. the percentage of homozygous alleles in the overall genome). Their homozygosity ranged between 61,6 % and 66,5%, i.e. they differed by almost 5%, although from the pedigree you would think they should be exactly the same. Although such a difference may not be crucial in one generation, it may well be important for a long-term breeding program. If you have a closed gene pool, such as the Straight Egyptians, diversity should be important. So, in case of these four full siblings, for which you need to decide which one to include in your breeding program, and assuming they are all equal in conformation, performance and other traits, you should choose the one with the higher diversity (lower homozygosity), as a higher diversity is beneficial for the overall health of your breeding program. This filly is going to be more reproductively healthy and to have a stronger immune system.

Origin of Bloodlines

After having analyzed many horses as a ref-



erence population, it is possible to examine the DNA of a horse and compare it to this reference population, and then determine the proportion of his ancestry. At first, the computer was asked to cluster the reference group into the most probable sub-groups based on their genomics and NOT based on their pedigrees or their geographic origin! These clusters were then colored, to make them easier to differentiate. So this statistical procedure of clustering the horses based on their genomics works without any prior knowledge derived from human history or pedigree - and that's important! Only after these clusters were defined, the horses in these clusters were being looked at and allocated "labels" such as "Polish bloodlines" (yellow), "Egyptian bloodlines" (red), "American domestic" (blue), etc., according to their respective pedigree information. It turned out that most of the horses of each cluster had the same color (i.e. bloodline), with the one or the other odd exception.

Now, the result for a sample horse may be that 50 % of his ancestors can be attributed to the blue group, 25% to the yellow group and 25% to the red group. The result can be displayed in colorful bars for the breeder to easier understand.

The group of Samantha Brooks also used the same approach to examine four founder individuals of the Nagel herd. And the majority of the genomes were red (i.e. Straight Egyptians), as they should be. But even after 50 years of careful "Straight Egyptian" breeding, some colors of other ancestors were included, e.g. yellow, which was earlier identified as Polish. How come? Do these Straight Egyptians have some Polish blood? No. The problem is that it is not possible to date the common ancestor. It is therefore quite likely that this yellow bit in the Straight Egyptians, has a common ancestor with the foundation horses of the Polish breeding program, for example, the desert-bred imports that came to Poland in the course of time. If a relative of these desert imports went to Egypt, they both share common ancestry, hence it shows in the graph as yellow, as this ancestor was allocated to the Polish population. The "yellow group" is actually pieces of DNA that you find commonly in modern-day Polish Arabians, but 200 years ago, you probably found them in the Middle East and the Fertile Crescent. However, with the same method, it was possible to classify the Nagel herd





as a cluster within the Egyptian cluster, defining it as a unique subgroup of the Straight Egyptians.

Conclusion

With genomics, it is now possible to analyze the genotype and thus predict the phenotype of a foal with regards to height, color, some individual performance traits, and genetic diseases. It will be possible in the future to have genotype records for frozen semen so that breeders can go shopping based on genotypes, rather than on pedigrees and performance records. If the mare is genotyped, too, you can search specifically for a suitable mating partner. You can test embryos by testing single cells before transfer, to determine their genotype and select the embryo that you want. This is the standard procedure world-wide in dairy and beef production, and commonly used. "Making breeding decisions based visually on phenotype or pedigree is very imprecise and was discarded 10-20 years ago in modern agricultural practices. Everything now is done by genetics. It has increased the accuracy by an enormous magnitude", says Samantha Brooks.

So far, not many of these measures are used, and none anywhere near their potential or capacity. And although genomics is an intriguing science, it can be used and misused, just like any modern scientific advancements or inventions. Technically, everything is feasible, but not everything that is technically feasible is also reasonable to do, or morally permissible.