Linebreeding (1)

In order to know how to use linebreeding, you must know what it is capable of doing. I recently bought a laser transit. I didn't know much about such a tool, other than the fact that it would allow me to determine level points along a line that could be several hundred feet long. I was building new breakout pens that had wire sides and it was very important that the tops of the metal support poles be exactly the same height. So off I went to Sears and found a whole rack of laser transits to choose from. I bought one that would do what I wanted and returned home quite smug that I had saved $50 by not buying the top of the line model. I remained smug as I set the poles. Only after I had finished the project did I find out that for 15% more than what I paid, I could have purchased one that had auto leveling and a remote control swivel feature. These options would have allowed me to do the job in less time and with half the labor. My point is that sometimes when we don't know what a tool will do, we blissfully think that we are using it properly and fully taking advantage of what it can do for us. Linebreeding is one of those tools that many fanciers may not be using to their fullest advantage.

Ask just about any pigeon breeder "what is linebreeding?" and they will likely tell you (correctly) that it is the breeding of animals which have a common ancestor. Press a little further and ask, "why do it?" and a good many will explain (not incorrectly) that it increases the influence of the common ancestor in the resulting offspring. But what does that really mean and how does it work? Is it a sure fire technique or something of a long shot? Is it really a tool that can be used in a small backyard loft or is it something whose benefit can only be attained in the setting of a commercial breeding operation? Does it come with a self leveler and a remote controlled swiveler?

Lets start at the end by looking at what linebreeding can accomplish. I will describe three problem situations which we all face from time to time for which linebreeding can provide a solution.

1) You are interested in a particular pigeon for the purposes of breeding. For whatever the reason, the pigeon is unavailable to you. It might be dead or lost or sterile. It might not be for sale or, as is often the case, prohibitively expensive. It might be a bird you culled to make room for up and coming youngsters and then found out a year or two later that its offspring are your best flyers. It might even be a pigeon who has been dead for twenty years. (This last thought will certainly provoke an outcry from some readers who will say you can't breed pigeons that win today by selecting around pedigrees with birds that raced twenty years ago. We will address that issue later in the next article.)

2) You have been blessed with a "once in a lifetime" bird. Oh, what you wouldn't do to have a loft full of birds like that one!!!

3) You have just come from an auction where you spent every spare dollar you could put your hands on to buy the bird that will be the future of your loft! Or so you hope. If you are correct, then there is no problem here. If it doesn't work out that way, you could be setting your breeding program back a decade or more. How can you effectively evaluate the breeding potential of this purchase without unreasonably risking the future of your loft and yet not waste valuable time if the purchase was, in fact, the real deal?

To understand how to use it though, you must understand how it works. It is really very simple and I will summarize it in a sentence or two. Then I will explain it in much more greater detail. As dry as the detailed explanation will be, I urge you to stay with it to the end. Those details are meant to give you a sufficient understanding so that the high level summary will stay with you. Finally (in the next issue), we will loop back and explain in detail how to resolve each of the three problem situations above using the tool of linebreeding.

There are three key concepts at work in a linebreeding program that you absolutely must understand.

1) Linebreeding **concentrates** the genes of a particular individual in the gene pool from which you are breeding.
2) With every mating, the gene pool is **shuffled** and then a discrete sample of those genes is **dealt** to the new chick.
3) What you visibly see (or measure) in this new bird is the result of just a part of the birds genetic composition (many of its genes remain hidden) and what you do see will often be dramatically influenced by the birds environment. In other words, a winning (or losing) hand **isn't always obvious**.

With linebreeding, we are basically "stacking the deck". Most people understand this. What is often not realized is that stopping there does little to make linebreeding a winning strategy. To truly be effective, a linebreeding program must recognize that not every hand dealt is a winner even when you play with a stacked deck. Stacking the deck means you will win more often, but not every time. A losing hand from a round of linebreeding is still a losing hand. The key to winning this game then is three fold:

1) stack the deck as much as you can,
2) play lots of hands,
3) know a winning hand when you get one.

To put this "game" analogy into perspective, I would like to put forth some numbers.

Speaking in broad generalities, I would like to consider the frequency with which champion racers are produced by four tiers of breeding pigeons. I will call the top tier "elite world class pairs". When I think of birds in this group, I think of Karl Meulemans' golden couple. There are of course others, but this sets an example of the caliber of birds that I include in this group. The second tier consists of the top pairs in a combine or province. These birds are very special too, but they are more abundant than the birds of the top tier. The third tier is comprised of the top pairs in an average loft and is a larger group than the second tier. I'll define the bottom tier as all other pigeons and it is of course the largest in size.

It is my contention that even the finest breeding pair in the world, does not produce a champion with every egg. The breeders of the top elite tier produce the best percentage and the bottom tier produce the lowest percentage. For the sake of discussion I am going to put forth some numbers that I use in thinking of these tiers. As soon as I write this, someone is going to say, "Well I have a pair that produces 90% winners". Those birds do exist and they probably belong at least in the second tier, but I want to make sure you don't miss my point. "Elite world class" means it is exceptional when considered against all other breeding pairs in the world. When I was in college, grades for large classes were typically given on a curve. An "A" was defined as exceptional and was usually reserved for scores that were greater than two standard deviations above average. As I said in my introduction, grades of "C" can still represent significant achievement, but "exceptional" (e.g. an A) by definition means it is rare. This is how we want to think of the top tier. I will explain why this is important later in the next article.

In my mind, pairs in the top tier might produce on average 1 great bird in every 10 produced. Pairs in the second tier might be expected to produce 1 great bird in every 100. Pairs in the third tier might produce a great bird in every 1,000 offspring. Pairs in the bottom tier can probably not be expected to produce a great bird at any frequency higher than 1 in 10,000 and perhaps much lower than that. These are the numbers I use. It is completely subjective. Use whatever numbers you want, but the points need to be that 1) no pair produces 100% world class champions, 2) there is a wide gap between the productivity of the top elite tier and the bottom tier of the masses and 3) most of the birds we produce are not the ones we are seeking.

Every time an egg is laid, you have been dealt a hand. The potential of that bird (genetics) is fixed and from that point on its environment (largely controlled by the fancier) will determine how much of that potential is realized. Much of the racing pigeon literature concentrates on this latter aspect. It is, of course, extremely important if you expect any measure of success in pigeon flying. What we are discussing though is the dealing of the cards. Our objective is essentially to figure out how to cheat Lady Luck. Recognizing that even when we are at the top of our game, every chick will not be a winner, we still must strive in our breeding program to reduce the role of luck and increase the role of design.

I suggest our design should be based on two objectives. First, we want to make sure we have the correct genes in our breeder pool. If a fancier were to start with two pair of feral pigeons they caught in a barn, it might take a lifetime just to get a bird that could be generously called "competitive". Second, we want to increase the frequency of these "correct" genes in our breeding flock. In terms of our analogy, we want to play blackjack against the house, but our deck has all face cards and aces.

Now since all racing pigeons may have descended from a few common ancestors hundreds or thousands of generations ago, the concept of linebreeding only makes practical sense if the common ancestor(s) appear fairly recently in the pedigree. It is somewhat subjective how far back you go. Many people will go back three generations and dismiss any contributions further back. I tend to look for common ancestors as far back as the 9th generation, but if the total contribution of all the ancestor's occurrences isn't at least 10% then I also generally disregard it.

There is an algorithm for calculating what is known as the "linebreeding coefficient". This number is actually very useful in evaluating the influence of a linebred ancestor. We'll consider it later. For now though, we are going to use "Percent Contribution". This is a much simpler calculation and it will meet our initial needs.

The following table lists the Percent Contribution of an ancestor in each of the first ten generations:

Generation	Contribution of Ancestor
1st	½ or 50.00%
2nd	¼ or 25.00%
3rd	1/8 or 12.50%
4th	1/16 or 6.25%
5th	1/32 or 3.13%

6th	1/64 or 1.56%
7th	1/128 or 0.78%
8th	1/256 or 0.39%
9th	1/512 or 0.20%
10th	1/1024 or 0.10%

What this means is that, in theory, each parent contributes 50%, each grandparent contributes 25% and so on. Here are some examples:

1) A bird that is produced from a **father - daughter mating** is linebred around the father since he appears twice in the pedigree. The father's *theoretical* Percent Contribution is ½ (from being the sire) + ¼ (since he is also the grandsire). The total contribution of the father is 75%. He has contributed more than he would in a mating of this same sire and an unrelated hen.
2) A given bird can be linebred around more than one ancestor. Here is a **mating of cousins** and represents linebreeding around two different individuals "Ancestor A" and "Ancestor B". Each of these common ancestors *theoretically* contribute 1/8 + 1/8 or 25%. Note that this is the same contribution we would expect if the ancestor had appeared only once but one generation closer.

```
                                    /   Ancestor A
                      Sire 1
                    /               \   Ancestor B
              Cousin 1
                    \               /   C
        /             Dam 1
                                    \   D
offspring
                                    /   E
        \             Sire 2
                    /               \   F
              Cousin 2
                    \               /   Ancestor A
                      Dam 2
                                    \   Ancestor B
```

3) Here is a more extreme example and represents three **successive generations** of breeding an outstanding cock to his best daughter:

```
                                    /   A
                      G
                    /               \   B
              Great Male
                    \               /   C
        /             H
                                    \   D
offspring
                                    /   G
        \             Great Male
                    /               \   H
              Daughter 2
                    \               /   Great Male
                      Daughter 1
                                    \   Original Mate
```

The *theoretical* contribution of the "Great Male" is ½ (as the sire) + ¼ (as the grandsire) + 1/8 (as the great grandsire) or 87.5%.

The reason these contributions are *theoretical* is very key. The contribution of each parent is in fact 50% (note: I received an interesting question from the last article about the relative importance of the cock and the hen in the outcome of a mating. This question and answer can be found [Steven – insert reference]. In the answer I explain why the precise percent contribution of the parents of a cock is 50%, but for a hen the parental contributions are 50.63% for the sire and 49.37% for the dam. For the purposes of the discussion here, we'll call the contribution of direct parents 50%). Now when the offspring themselves reproduce, they make egg or sperm cells that each contain half of their genetic material (this genetic material resides on chromosomes). When an egg is fertilized with the sperm cell, the resulting fertilized egg again has the correct number of chromosomes. Here is the point that many people miss. While the egg or sperm cell represents exactly half of the parents chromosomes, it does not represent exactly one quarter of each grandparent! The reason for this is that in the process of making gametes (egg or sperm cells), the chromosomes undergo what is known as "cross over". Each pair of chromosomes (which originated one from each parent) actually break and rejoin. So when one of these new rejoined chromosomes is passed on to an egg cell, it actually carries genes from both of the hen's parent. This happens for each of the 39 autosomal chromosome pairs (the sex chromosome pair is different and is discussed in the question and answer discussed above). Consider this visual representation (Lets simplify the situation and pretend pigeons only have one pair of chromosomes):

Cock A and Hen B produce Offspring C who produces gametes like these

aaaaaaaaaa
aaaaaaaaaa

X = aaaaaaaaaa => aaaaaaabbb , aaaabbbbbb , aaaaabbbbb
bbbbbbbbbb bbbbbbbaaa , bbbbaaaaaa , bbbbbaaaaa etc

bbbbbbbbbb
bbbbbbbbbb

Now while the statistical average for all possible gametes of a bird will be an equal contribution from each grandparent, that will not be the case for each individual gamete. In the above example, six gametes are shown, but only two represent equal contributions of the grandparents. If you were to somehow measure this and graph it, it would be a distribution curve where only the middle of the bell shaped curve would represent an equal 25% contribution from each grandparent. In theory this bell curve has 0% contribution of a grandparent on one extreme and 100% contribution of that same grandparent on the other extreme. Now just like you could conceivably toss a balanced coin and get 1000 "heads" in a row, it would be such a rare event that no one would expect that outcome on a given toss. But while the extremes are very unlikely, don't lose sight of the fact that a hundred offspring from a given pair will not all have the same percent contributions from each of its ancestors beyond the parents. This means that we have the potential for unusual combinations to result. If we put a particularly outstanding individual several times in the pedigree, we have the potential for a combination which carries a very significant amount of genetic material that comes from this individual.

Remember though, that there will also be many combinations that don't and we must test and cull rigorously if the linebreeding program is to be successful.

Let me close for now with two questions for you to consider. We will pick it up from here next time.

1) I think the Janssen Brother's "Oude Merckx" was an exceptional breeder. He shows up behind so many great racers and families. Let's assume you share this view and you have found a fertile cock which you can afford who has an exceptional race record and whose percent contribution from "Oude Merckx" is 20.3% (e.g. he appears 8 times in the 5th and 6th generations). Lets also assume you are not happy with your current gene pool and you are looking to improve. Ponder what you would do. If you elected to obtain this cock, how would you manage his breeding program? There are of course no right or wrong answers here. This is just a scenario that will give rise to a rich discussion.
2) Lets assume you have identified a superior racer. Like the first question you are not happy with your current gene pool and are looking to improve your lot. The breeder of this pigeon is retiring from the sport and holding an auction where the following lots of birds that are related to this pigeon are going to be sold. Lets (unrealistically) remove from consideration other real world issues and assume for the sake of our discussion that all of the offspring at the sale are of acceptable conformation and health. The flyer who owns this ace pigeon breeds from a family that he has kept for over 20 years with some, but infrequent, outcrossing. What are you going to do? Again, no right or wrong answers, just good fodder for discussion.

    1) The Ace Pigeon. This is the first lot to sell. If you buy him you will have no money left to buy any others. The pigeon is 9 years old and still fertile.
    2) The dam of the Ace Pigeon. She has produced two other Ace Pigeons when mated to two other cocks. She is 11 years old, but earlier this season she had one fertile egg. There are several months left in the breeding season. She will cost half you budget.
    3) A squeeker that appears to be a cock. He is out of lots 1 and 2. It will cost half your budget.
    4) A kit of ten grandchildren of the Ace Pigeon. Four cocks and six hens. This kit will cost all of your budget.
    5) The sire of the Ace Pigeon. He is 10 years old and still fertile, but the Ace Pigeon is the only significant offspring he has produced. All others were average flyers. He will cost you half your budget.

6) A yearling cock and yearling hen directly off the Ace Pigeon. It will cost all of your budget.
7) A yearling cock off the Ace Pigeon. He will cost half of your budget.
8) A yearling hen off the Ace Pigeon. She will cost half of your budget.
9) Five squeeker grandchildren of the Ace Pigeon. They will cost half of your budget.