Proc. Iowa Acad. Sci. 90 (1): 26-27, 1983

Pedigree Style in Teaching Genetics[1]

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A single pedigree style, the arrow or network method, is presented that is generally superior to, or as useful as, the other commonly used methods in teaching genetics. It is adaptable to all uses of pedigrees and necessary in some. Clarity of inbred relationships, generation overlap, and lack of the need for right angle turns are the major advantages.

INDEX DESCRIPTORS: Pedigree style, teaching genetics.

Several types of pedigrees are used in animal and plant breeding, genetics problems, and genealogy. The well known line bifurcation style (Fig. 1) of animal science is not adaptable to many genetic problems. Further, it is inefficient in that inbred lines may have the same individual's name written down several places. In Fig. 1 "Favorite" is written 5 times in the ancestry of Lancaster, although this is not immediately obvious, nor is the fact that "Favorite" was mated back to his own mother to produce "Y. Phoenix." Presentation of this same data in the network or arrow style (Fig. 2) makes the multiple use of "Favorite" obvious even though his name is written only once. Further, the sex is readily distinguished by using dashed lines for the female contribution or line of descent. Alternatively, the sex symbols ♂ and ♀ may be used.

Such a network pedigree not only clarifies the breeding system but corrects the first impression one gets regarding the number of grandparents and the number of generations. In Fig. 3a there seem to be 3 ancestral generations, and there seem to be 7 great grandparents instead of the expected 8 (1 repeated). But "SPEEDY" actually has 5 ancestral generations indicated, and only 2 great grandparents (Fig. 3b).

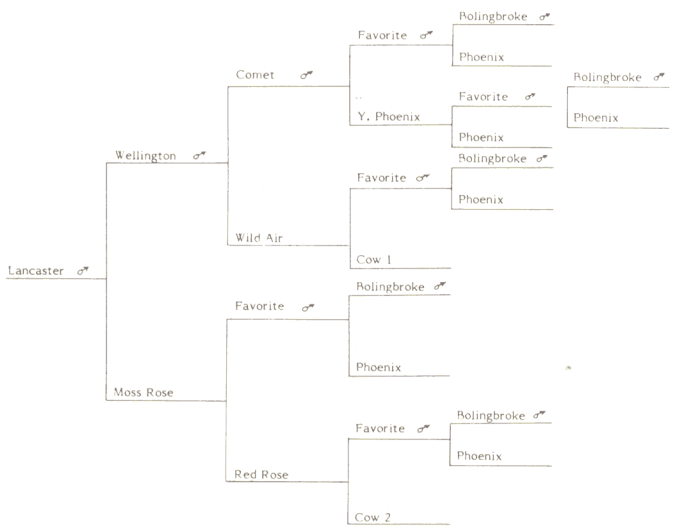

Fig. 1. Bifurcation Style. Partial pedigree of the origin of the shorthorn breed of cattle (after Wriedt 1930).

[1]Journal Paper No. 29 College of Agriculture, Iowa State University, Ames, Iowa.

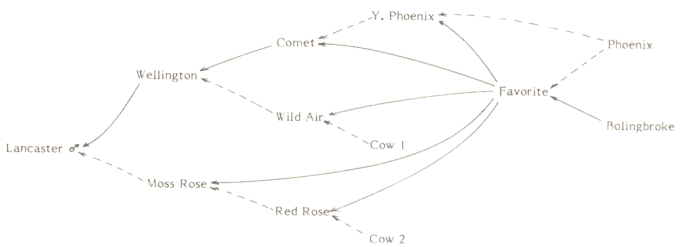

Fig. 2.Network or arrow style. Partial pedigree of the origin of the Shorthorn breed of cattle (after Wriedt 1930).

The traditional square and circle of human pedigrees have only limited uses genetically and are awkward in handling more than 2 marriages (not illustrated). The classical genetic style (Fig. 4) employs the P_1, F_1 and F_2 symbols in Mendelian problems. Since it is used vertically, the most interesting results appear at the bottom of

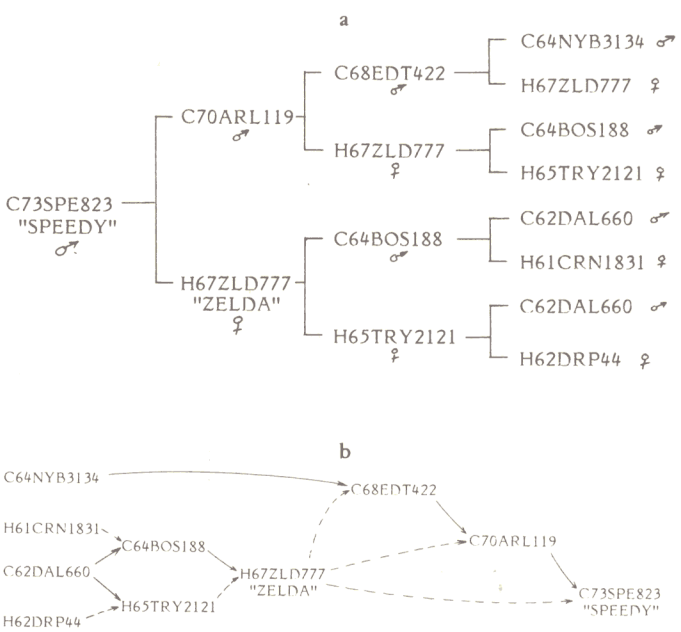

Fig. 3.A racing pigeon pedigree: a)conventional, b)arrow pedigree, no repetitions.

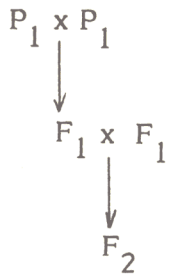

Fig. 4. Classical genetic style.

the blackboard where they are hard for students to see. Further, it requires frequent awkward separation or extension to one side.

The network pedigree style (Hollander 1944, 1971, 1972, 1980) surprised me in being generally adaptable and appropriate to all kinds of uses. It goes sideways on the blackboard very well. Left to right, as one normally reads, is convenient, but any direction is easily interpreted. Many lines of genetic contribution may come from one individual in an efficient use of space. These lines can fan out by arrows indicating direction of genetic contribution, to point to all progeny, in any generation level, wherever they occur, by whatever parents. It is ready made for the calculations of coefficients of inbreeding and relationship. These require the line diagram style back to ancestors common to both parents. Essentially it is that style (see Lush 1945) slightly modified to fit the P_1-F_1-F_2 or backcross needs of the Mendelian problems. Gene symbols, phenotype names, or both may be placed most conveniently as needed.

Figure 5 illustrates this new application of an old style (as used by Lush 1945) to a classical Mendelian dihybrid problem for comb shape in chickens. The phenotypes alone may be entered originally. Then, as desired, gametes may be inserted or omitted between generations. Either the full genotypes or shorthand designations (as

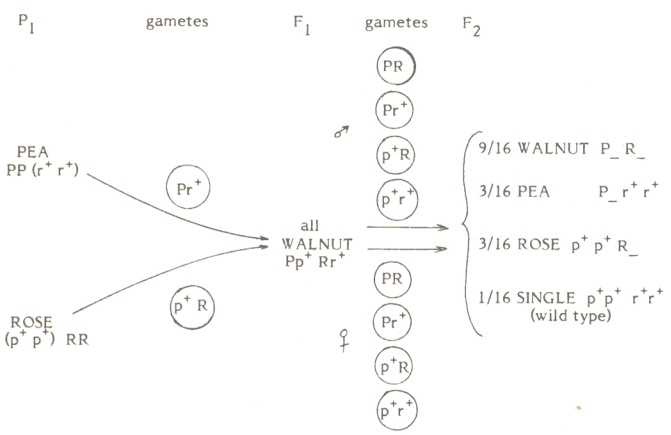

Fig. 5. Arrow pedigree for the classical problem of comb shape in chickens.

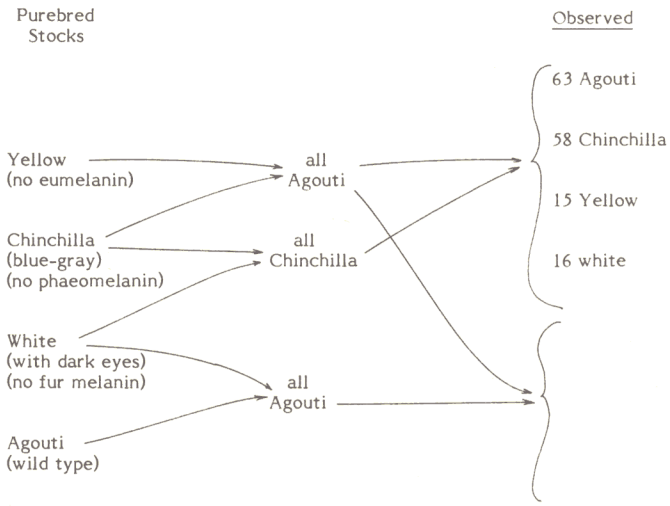

Fig. 6. Some coat color inheritance in rabbits. Agouti is the wild-type. Fill in the missing genotypes, phenotypes and frequencies.

in Fig. 5) may be used. The 2 arrows extending from the F_1 may imply selfing (in plants) or it may imply that like was mated to like of opposite sex, thus conserving space and avoiding clutter. There is no "x" indicating a cross to get mixed up with the X chromosome or a gene symbol. The bracket indicates 2 or more individuals or kinds of progeny; that is, all offspring are full sibs.

Mixtures of types of matings can easily be diagrammed in the arrow style. That is, P_1, F_1, F_2, testcrosses or other crosses in the same overall problem can be used to ask students to integrate what they have learned. For example, coat color in rabbits, as illustrated in Fig. 6, makes an interesting problem with a testcross for one gene pair and an F_2 for the other in the top family. The analytical abilities of the student are tested for mutants held in common, gene action, number of gene pairs, and for dominance versus recessiveness. When actual numbers testable by X^2 are inserted, this problem is two steps closer to a real breeding data situation than the formal F_2.

It took several years of teaching with alternative usages to become convinced of the superiority of this arrow or network style. I hope you will try it before your habit patterns in genetic usages harden.

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