APPLICATIONS OF POPULATION GENETICS TO FOREST TREE BREEDING

by John E. Grafius[1/]

(The following is a brief synopsis of the talk Dr. Grafius presented. For those interested in further study of this problem he suggests the list of references at the end of the synopsis.)

No attempt was made to translate farm crop breeding methods to forestry. Rather, some of the more simple tools were displayed and some of the pitfalls described.

Since selection is the key to progress, one of the first questions that must be asked is, "How much of what I select for will I retain in the next generation?" Basically, this resolves itself into two parts, heritability of a trait or h^2 and the selection differential i. Expressed algebraically, genetic gain $AG = h^2 i$. The heritability of a trait was defined as the ratio of the additive genetic variance to the phenotypic variance. A simple model was used to derive the additive genetic variances, the nonadditive variance, and environmental variance. Several ways of doing this, including full-sib families and parent-progeny regressions were stressed.

The importance of genotype-environment interaction was discussed. The plant breeder must be wary of trying to select under an unstable environment.

Next it was pointed out that some so-called traits are mental constructs and not genetic entities. For example yield per acre in small grain is the product of (the number of heads per unit area) x (number of kernels per head) x (average kernel weight). Since these three things are not correlated, there is no set of genes for yield per se and one must select for the genetic traits rather than yield per acre. In other words, if there are no genes for a trait, the heritability values are spurious.

Lastly, instances of tunnel vision were cited where the breeder ended up with resistance to everything - including yield. The necessity and the feasibility of breeding for the whole organism rather than a single trait was stressed.

Selected References

Grafius, J. E. 1952. A statistical model for estimating components of genetic variance in bulk yield tests of self pollinated small grains. S. Dak. Agr. Expt. Sta. Tech. Bul. 9, 13 pp. (For a more detailed analysis of variance problems; much of the algebra is given.)

1/ Professor, Department of Farm Crops, Michigan State University, East Lansing, Mich.

________________. 1957. Biologic measurement of environment as an aid in selection. Agron. Jour. 49: 506-508. (For a discussion of genotype - environment interaction.)

________________. 1959. Heterosis in barley. Agrom Jour. 51: 551-554. (For a discussion of "artifacts" on the confusion of mental constructs with reality.)

Lerner, I. M. 1950. Population genetics and animal improvement. 342 pp., New York. (For a discussion of expected genetic gain.)

Mather, K. 1949. Biometrical genetics. 158 pp., New York. (For the methods of calculating genetic variances and a clear explanation of symbols.)

Group Discussion

There was further elaboration of what the plant (tree) breeder can aim for. It was emphasized that economic and genetic traits should not be confused; that one cannot breed for something like "yield per acre." It is possible however to breed for many of the components that contribute to yield. If selecting for a certain product were the aim probably some of the values for that product could be raised but selection for individual characters would be more efficient.

It was pointed out also that some leeway should be allowed in breeding for disease resistance. Pathologists, as a rule, want types completely immune to diseases. In forest practice, however, we start with a large number of trees per acre and have a much smaller number at rotation age. Many trees, including those somewhat deficient in disease resistance, are removed in thinning. The plea was made, therefore, not to discard material, otherwise desirable, that is less than completely immune to disease attacks.