In Second Meeting Working Group on Quantitative Genetics, Sec. 22, IUFRO, Aug. 18-19, Raleigh, N.C.

HYBRIDIZATION...APPLICATION TO PINE POPULATIONS

M. Thompson Conkle[1/]

"Can hybridization between species and races produce superior forest trees?" In the 1920's and 1930's, some lumbermen and scientists alike were asking this question. They were impressed by the work of Luther Burbank, whose improvements in vegetables and flowers were being achieved by hybridization. And some of his hybrids far surpassed varieties previously available. Could not some of this techniques be tried to develop better forest trees? James G. Eddy and others interested in tree improvement provided a means of finding the answer. They founded at Placerville, California, the Eddy Forest Tree Breeding Station, now the Institute of Forest Genetics.

The importance of interspecific and interracial hybridization in the evolutionary and plant breeding histories of commercially valuable crop plants is now generally recognized. Among these crops, wheat, oats, cotton, tobacco, and sugar cane are allopolyploids originally derived from hybrids between highly different species. Many of the most popular perennial herbs and shrubs, as well as orchard and arbor crops, are hybrid in origin. Many poplar clones grown in Europe are derived from hybridization between the American *Populus deltoides* and the European *P. nigra*.

WHY HYBRIDIZATION?

We know, or can infer, that introgression following natural hybridization has resulted in the exchange of genetic material between species. Examples in plants are numerous enough to indicate that it is a successful and desirable evolutionary strategy. From the genetic standpoint an argument can be advanced that genetic variability is increased through hybridization.

The basis of quantitative genetics in plants is the study of genetically controlled variability. A basic prediction formula estimates the amount of gain possible by genetic improvement. This formula shows the response to artificial selection conditioned by three factors: (a) the selection intensity; (b) the heritability of the trait or index of traits being selected; and (c) the phenotypic variability of individuals or families in the population. The selection intensity accounts for the proportion of the population selected. Heritability measures the genetically controlled resemblance between related individuals. Lastly, the phenotypic standard deviation measures observable variation resident in the population before selection.

1/ Geneticist, Pacific Southwest Forest and Range Experiment Station, USDA Forest Service, Berkeley, California 94701

Maximum responses to selection are obtained when characteristics have high heritabilities and when the phenotypic variation is large. It is reasonable to assume that more phenotypic variability exists between races of trees than within; likewise, more variability exists between species than within. It is very likely, therefore, that in the future, genetic material outside the gene pool of a wild species will supply new, usable genetic variability for tree improvement programs. The same reasoning can be advanced for attempting interracial crosses with a species.

EXPLORATORY WORK IN PINE HYBRIDIZATION

The use of species hybridization in pine improvement has gone through several phases. The history of the Institute of Forest Genetics demonstrates this point. First, seedlings of various pine species were established in arboreta, and techniques for controlled pollinations were worked out. Subsequently, exploratory work with species showed that some would cross, others would not. These relationships roughly paralleled taxonomic relationships based on morphological characteristics. Of the species that crossed, they differed widely in ease with which hybrid seed could be produced. This crossability largely determines how hybridization can be used in pine improvement.

THE USE OF PINE HYBRIDS

Hybridization in pine improvement can be approached in three ways. First, for the attempt to transfer desirable characteristics from one species to another, as when genetically controlled disease or insect resistance is found in one species but lacking in others. If resistance is simply inherited, one or a relatively few species hybrids may be all that are needed for the transfer of the characteristic. Thus, crossabilities might be extremely low but the method useful.

Second, for the attempt to produce a highly heterozygous base population for future selections. In a wide ranging species, different races are likely to exist as a result of natural selection. Theoretically, there is merit in bringing together genes from diverse races through "wide crossing." Such a population should be a fruitful source of material from which artificial selection could progress.

Interspecies hybrids might likewise be a desirable starting point for future selection. For both the interracial and interspecies production of heterozygous populations, relatively large numbers of parent trees should be represented. Therefore, the species would need to be highly compatible.

Third, in the attempt to produce an F_1 hybrid combining the best traits of two species or races. For instance, the rapid growth of one species may be desired with the site tolerance of a second. Again, the two species must be highly compatible to produce quantities of F_1 trees as well as to utilize their better genotypes.

RECIPROCAL RECURRENT SELECTION APPLIED

I am currently working with an interspecific hybrid that has demonstrated promise in certain environments. The hybrid between Monterey pine (Pinus radiata) and knobcone pine (P. attenuata) combines the rapid growth of the Monterey with good site tolerance of knobcone pine. Both species are highly interfertile, making quantity production of hybrid seed possible. I am applying a genetic improvement method known as reciprocal recurrent selection. Two separate populations are maintained under this selection method. The genetic worth of individuals is judged from test crosses with individuals in the alternate population. In each population, superior parents are intercrossed to form new populations for further selection. Two base populations--trees from throughout the native ranges of Monterey pine and knobcone pine--are available. Hybrid progenies from single trees in each species will be tested. The aims of the study will be to: (a) identify parent trees which produce better than average hybrid progeny; (b) use "select" parents within each species for hybrid production; and (c) select parents within each species for cross pollination to produce new populations of Monterey and knobcone pines for a second cycle of selection.

DESIRABILITY OF HYBRIDIZATION

Because of genetic variation among pine species and races, hybridization may be the only way to combine desirable traits into a single product. Exploratory work provides the basic information on the ease of hybrid production. And since a combination of different traits is desirable, species hybridization ought to be tried whenever the aim is (a) to transfer desirable traits from one species to another; (b) to produce highly heterozygous populations for future selection work; or (c) to combine unique traits provided by the F_1 interspecific hybrid.